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ENGINEERING AND
MINING JOURNAL

METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

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Concentrating and Leaching the Kennecott Copper Ore

By E. J. Duggan

◆

Occurrence, Mining, and Concentrating Tin Ore in Malaya

By Frank D. Adams

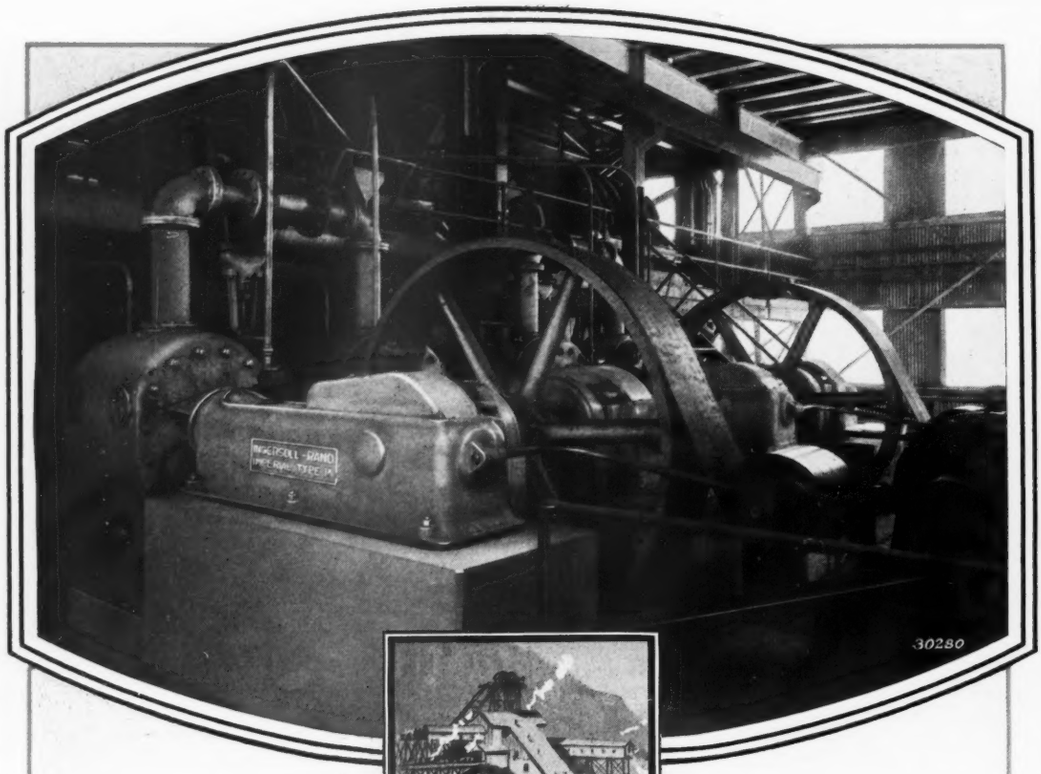
◆

Favorable Areas for Prospecting in Canada

Tin Occurrences in the Carolinas

Cost-Cutting Innovations

Mining Dividends for December



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Reprints of Important Articles Are Available

WHILE THEY LAST, we will be glad to mail reprints of several important and timely articles that have appeared in recent issues of *Engineering and Mining Journal*. These include an editorial monograph on "Automatic Indicating and Recording Instruments"—of particular interest to smelter and power-plant engineers; "The Harris Process of Lead Refining"; "Adit Driving at Ojuela, Mexico"; "South America's Leading Mining Industry—Nitrate"; "Geophysical Exploration," and "The Sullivan Electrolytic Zinc Plant." If no action follows a request for copies, please understand that the supply of reprints of these articles has been exhausted.

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Co-ordinated Publishing Facilities . . . and Better Magazines

WITHIN THE LAST HALF-YEAR the facilities of three important publishing houses serving business and industry have been brought together. The McGraw-Hill Publishing Company, the A. W. Shaw Company, and the Textile World organizations are now under one general direction. There are in the group 24 magazines, covering business broadly, giving an intensive service in 10 fundamental industries, and published at such widely distant points as New York, Chicago, San Francisco and London.

The spirit animating this co-ordination of related publishing activities is a response to the increasingly severe and exacting demands upon business publishers. It springs from a recognition not only of the desire but also of the necessity for broadening and strengthening the service of the publications to their respective fields. It is in harmony with the spirit of progress and growth so characteristic of industry and business in this country. It is broader than the mere desire to be in step with business tendencies. The business press, if it is not to lag in the leadership it has attained in the past two decades, cannot rest on its record of performance. It must keep a step in advance, must have the forward look.

The direct effect will be to expand the gathering and dissemination of significant news, to insure the recording of all important developments, to provide authoritative interpretation of events, and to strengthen the activities of each publication through internal co-ordination and co-operation. Publishing facilities for the group as a whole will be enhanced beyond those which any single paper or lesser group might enjoy, and these advantages will find expression in better publishing media for the service of American business and industry.

Advantages of Co-ordination

DOES IT REQUIRE publishing experience to see the value of co-ordinating publishing facilities? The co-ordinated organization can throw a drag-net over the industrial, engineering and business world; it has the personnel and the facilities for covering all new events, ideas and developments. Today, on the McGraw-Hill publications there are 128 editors specializing in interpretative, creative, technical, commercial and research writing or investigation. Each paper has its own independent staff and is served, in turn, by an effective news-collecting agency, which has the needs of every staff in mind and which knows the interests of the readers of each publication. At the same time each individual publishing staff naturally stimulates and supplements the others through exchange of information from different fields of business and industry.

Thus the collection of data on new developments is broader and its interpretation more authoritative. The leadership of the papers along the avenues of sound progress is surer and more aggressive.

This has been our experience with the entry of every new paper into our group. Heretofore, our publications have been devoted to the basic engineering industries and to specialized fields of merchandising. They cover industrial management and the electrical, power, metal-working, textile, bus, electric railway, construction, mining, radio, chemical and food industries. Most of them are built on the five fundamental engineering professions.

Just now we expect a particularly great stimulus within the organization from our association with *The Magazine of Business.* For all the other McGraw-Hill publications *The Magazine of Business* now forms a capstone.

It is in truth a magazine of American business, for it serves the policy-forming executives in all branches—in trade, industry and finance, and in all of the servicing branches, such as transportation, communication, power, insurance and warehousing. It goes to many men who already read McGraw-Hill and other industrial papers. It in no sense replaces them. It talks to specialists, not as the industrial paper does, in terms of their specialties, but in the broader terms of those factors which affect all business from without. It will, therefore, bring to each McGraw-Hill publishing staff a broader sounding of the whole stream of business. At the same time *The Magazine of Business* will draw upon all of these editors for an intimate understanding of the flow of business, as these 128 trained observers see it from day to day in their visits and correspondence with thousands of business men, engineers and industrialists in specific industries. The help of these editors will be all the more valuable because of their intimate contact with science and engineering which are the bases on which modern industry and business are built.

A Great Responsibility

IT IS IN THESE WAYS that, through improved editorial service, the public benefits from the co-ordination of publishing facilities. There are returns to the public, too, through co-ordinated advertising and circulation activities; through economies in production, in purchasing, in administration. All of these enable more money to be spent on the primary service—that of building a better editorial service for the reader.

We are fully conscious that our magazines are an important and direct avenue to the minds of America's business men, her industrialists, and her engineers. Apart from any wish of publisher or reader, such an avenue is bound to create business and industrial opinion and, therefore, affects American business, and, indirectly, the whole American public. Ours is a responsibility of which we are keenly aware. We propose conscientiously to discharge it in the interests of business and the public.

ENGINEERING AND
MINING JOURNAL

McGRAW-HILL PUBLISHING COMPANY, INC.
JAMES H. McGRAW, *Chairman of the Board*
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The Smithsonian—Its Annual Report

AN INSTITUTION such as the Smithsonian—"a private foundation, the ward of the United States, engaged in many types of activities, international in scope and catholic in its attention to science"—may be properly termed unique, and any account of its work may be expected to be full of interest. The annual report of the secretary for 1927 abounds in items that catch the eye and beguile the attention. Because of its wideness, geographically and topically, the field of the Institution's activity appeals to the stay-at-home and traveler alike, and to the specialist cramped within the confines of his particular calling. Browsing through the report, one reads: "The expedition to Africa . . . we saw 22 rhinos. . . . At Tula two native sultans joined forces with us. . . . Collecting microfossils in Europe . . . minerals in Mexico . . . ferns in Jamaica . . . Archeological work in China . . . the anthropological survey of Alaska." Then one learns that the Institution is not and has never been properly considered a government bureau, this popular misconception having arisen because it still administers for the government seven of the public bureaus, which arose from its early activities. The acting secretary's own field of investigation is astrophysics, it seems. Knowledge of four things about the sun is particularly needed at present. He proceeds to enumerate them. The award of the Langley medal to Lindbergh is duly recorded. Radio talks—shooting stars, oyster farming, snakes, the coins of Asia. Publications to diffuse knowledge—excursions on the planets, cold light, how beavers build their houses, fragrant butterflies, preventive medicine. The National Gallery of Art—three paintings were bought. To the collection of the Freer Gallery were added several pieces of ancient Persian pottery, a thirteenth-century Persian painting, and a black schist image of the Indian god Visner. The Bureau of American Ethnology has continued its researches among the American Indians and the excavation of prehistoric Indian structures.

The topic changing, one is informed that in the course of its international exchange service during the year the Institution handled over a half million packages of government scientific and literary publications. On top of this, the facts that sundry white-bearded gnu, impalla, greater kudu, blue monkeys, and monkeys with purple faces were added to the National Zoological Park, along with various eland, wart hogs, and civet cats—all this as one merely skims the pages. A pause here would probably reveal a veritable Noah's Ark. In conclusion, the death in 1927 of Dr. C. D. Wolcott, the fourth secretary of the Institution, is duly chronicled and a tribute paid his distinguished career. One has now reached the signature, but apparently the report has only begun, if volume be considered, for an appendix follows, 530 pages long. In this are included some 25 papers recounting scientific discovery in particular directions. The topics: evolution of twentieth-century physics (by Millikan); soaring flight; geological climates; at the North Pole (by Lincoln Ellsworth); the mind of an insect; X-ray examination of paintings; the lengthening of human life (by Irving Fisher); and eighteen others. All in all, the fact that the Smithsonian is a very wonderful institution is made evident in its report.

High-Grading Convictions Rare in Local Courts

ANY REPORT on the part of gold-producing companies to protect their product from theft is deserving of support. An amendment to the act now in force in California is proposed. The new provisions involve an annual license fee of $25 and a bond of $3,000, to be provided by each gold purchaser who does a gross business in excess of $500 per year. If less than this amount of business is done, the license fee is reduced to $5 and no bond is required.

The amendments are designed to help the small-town merchant who sometimes takes gold and silver from the prospector as an accommodation. Some claim that the amounts demanded for license fee and bond are prohibitive under the existing law and that the prospector is thereby discouraged because of his inability conveniently to market small quantities of gold. A new section proposed vests employees with the power of peace officers, to enforce the provisions of the law and to seize and hold ore if there is reasonable ground to assume that it has been stolen or otherwise illegally taken, and to hold it for use as evidence in any action that may be brought.

The proposed amendments to the existing state act represent an attempt to adjust difficulties experienced in its operation. They may or may not be a source of weakness; experience alone can tell. The most needed improvement, however, is a federal act that will automatically throw high-grading cases into the federal courts. Great difficulty has been experienced in securing convictions in local courts. The proposed legislation is therefore of the greatest importance, and national legislators who are interested in mining in the Western states should direct their energies toward securing the passage of this much needed federal high-grading law.

A Rich Superlativeness in Stock Selling Appeals

MANY have wondered why mining stock promoters of a certain type deliberately restrict their statements to mere improbabilities, whereas the broad horizon of the impossible and the utilization of limitless figures is there for the taking. Many a prospectus invites a closer examination because the claims therein possess a superficial plausibility; and a cursory examination, at least, is needed to prove that the venture in question must be classed among appeals to the ignorant. Many, however, will have noted with interest that this timidity in the use of figures has been abandoned by the promoters of the Arriba Gold Fields Limited, a concern that is unlimited in its prospects, with properties situated in New Mexico. The stock is being sold—or one fears that it is being sold—from Denver at fifty cents per share, but no subscription for less than 200 shares is accepted by the "investment bankers" sponsoring the project.

An "engineering report" accompanies the appeal for funds, signed by a "consulting engineer." It is an elaborate and, in spots, a poetic document. Under "Development" one reads that "It is not necessary to develop any of this property, as all of the ore is practically in sight. In making this report," states the expert, "I have estimated the tonnage to be forty-four billion six hundred and five million four hundred and forty thousand." Clarified into plain figures, this means: 44,605,440,000 tons. "It will not be any trouble," the report continues, "to get into immediate production, as the use of steam shovels is the only logical method of handling this ore to the mills. There is enough ore actually in sight to keep a one hundred thousand ton mill running, twenty-four hours a day for five hundred and fifty years, and more." A generous expansiveness in statement is to be noted.

The account then refers to the achievements of the Homestake, Utah Copper, Miami, Inspiration, and Phelps Dodge companies, concluding that "This proves conclusively that it is not unusual for bodies of ore such as gold and copper to be discovered in exceedingly large quantities." Waxing even more enthusiastic, the author of this amazing account continues: "Of all the world's large gold ore depositions thus far discovered, the Arriba is by far the largest, the most colossal, and gigantic that has ever been recorded in the history of mines. The Arriba, in the mining world, is comparable only to the Grand Canyon of Arizona in the scenic world. . . ."

Enough about tonnage! Now about "values." "The average values of this ore range from three dollars to eight dollars per ton, in gold alone, and it should be no trouble at all to strike a general average of six dollars per ton." No trouble at all! No sooner said than done! "When it is taken into consideration, that the upwards of forty-four billion tons of ore on this property, multiplied by six dollars, amounts to the stupendous figure of more than two-hundred and sixty-four billion dollars, it will be readily seen that this property is capable of yielding sufficient wealth to pay off the national debt several times over . . . this is the true status of this colossal monstrosity, as I firmly believe it to be."

Fifteen pages of similar buncombe follow, signed by sundry "renowned" and "prominent" consulting "engineers," most of whom use the initial M.E. or C.E. after their names. Meaty extracts from a mass of verbiage follow: ". . . I think it safe to calculate on a recovery of the following byproducts, silver 2½ ounces, mercury 3 pounds to the ton, and besides, the entire pulp can be converted into cement as it passes from the tanks." "This is not a free milling proposition. The gold is very fine; the best results will in my opinion be obtained by amalgamation and cyaniding." ". . . the orebodies are inexhaustible." "I have read of the famous Homestake in South Dakota, and the Treadwell in Alaska, but these properties are pygmies in size as compared to the Arriba." Another E.M., described as a former mill superintendent of the Homestake, affirms that "There is sufficient tonnage above mill-head, on this one particular section, to keep a ten thousand ton mill in operation for more than three hundred years."

Extravagance in statement could go no further, and no greater harm can be done to legitimate mining enterprise in the State of Colorado and elsewhere than by the deflection of savings into the hands of a group that naïvely confesses that "At this time there is no equipment on the property, as it is a virgin property that has never been defiled by the hands of man."

We predict that the countless billion tons of ore and the inexhaustible reserves of riches will remain untouched, and that the attention of those who are bent on profitable extraction will remain concentrated on the sucker-prospect's pocket book. The "colossal monstrosity" of a mine will remain *in situ*.

Value of Free Service Available to the Public

TO EVALUATE in terms of dollars and cents the service rendered to the public free of charge is a difficult task. The question, too, if such service is actually free is one that furnishes ample opportunity for debate. In a broad sense, however, much service is rendered free of charge. For instance, the practice at some garages of cleaning windshields, the delivery of customers' purchases by retail stores, and particularly the facilities offered by public institutions such as libraries and museums. Perhaps the most important example, however, of such service is that represented by the work of the various governmental departments and bureaus. These agencies, it is true, are supported by funds received from taxation, but the cost of their upkeep is so small for each person that the service rendered may be said to be free.

Almost every industry in the country is served to some extent by a federal bureau or a department that performs research and investigative work. These bureaus and departments issue publications, available without charge, that contain data otherwise extremely difficult for commercial agencies to procure. The U. S. Geological Survey and the U. S. Bureau of Mines have conducted research investigations on hundreds of problems that have confronted the mining industry, and in many cases the data resulting have been the basis for subsequent economic and commercial development.

Considerable public criticism of this "free service" work performed by government bureaus is heard at times, but a study of the situation will indicate that the government bureaus do not generally carry the results of their research to the point of commercial application.

This is usually done by company research, and through such experiment the results obtained by the bureaus are made applicable to the conditions prevailing at particular plants.

Technical progress in mining, in ore treatment, and the other branches of the mining industry is due in its entirety neither to the work of government bureaus nor to that of technicians employed by commercial companies. It would appear that this progress over many years may be credited to the combined efforts of both groups. And, if this be so, it is only fitting to acknowledge that federal "free service" has played an important and a creditable part in the progress of the mining industry.

Inaccurate Technical News in the Daily Press

EXPLANATION for the high standard of much of the technical news in the daily papers may be attributed to the services established by reputable technical publications for the dissemination of accurate and reliable data that possess general news value or human-interest appeal. The reader of a high-class newspaper thus has a double check on the authoritativeness of a considerable proportion of his technical news.

Unfortunately, all technical news in the daily papers is not as reliable as that derived from and credited to such sources. As an example, the December 15 issue of one of the leading New York newspapers contains a front-page story pertaining to the "recent" discovery of a new metal—beryllium, the use of which, it was claimed, would quickly revolutionize many industries; and other assertions on the subject were reported to have been made by a prominent chemist at a meeting of Chicago executives. Whether the speaker actually made these statements or whether they resulted from reportorial over-enthusiasm is not known; but it is perhaps appropriate to observe that recent propaganda that has for its purpose the glorification of the chemist has overreached itself in claiming credit for the advance of civilization.

Beryllium is not a recent discovery, unless the geological conception of "recent" is implied. As an element it was first detected in the mineral beryl, which has been known since antiquity, by Vauquelin in 1798. Wohler, a German chemist isolated beryllium as an element in 1828, just 100 years ago. Research in the commercial production of the metal has been under way for thirty years, and H. S. Cooper, an American, is credited with having produced the first sizable ingot in 1916. During the last ten years the production of beryllium in Germany and in America has been placed on a semi-commercial basis, though plant facilities at present are sufficient for the output of only a few pounds per month.

Plant provision is not the only limiting feature of beryllium production, however, for deposits of beryl and other beryllium minerals are scarce. It is inconceivable that beryllium will ever be a cheap metal, though the present production costs of about $200 per pound will undoubtedly be lowered. Research for additional data on physical properties, as well as a program of publicity and educational work, must be consummated before beryllium can attain industrial importance. The number of industries that will be "revolutionized" during the next decade by this "recent" discovery is likely to be small.

The harm done by the dissemination of misinformation of this nature is, of course, cumulative, and a greater reliance upon authoritative sources of technical data by the daily press would appear to be desirable.

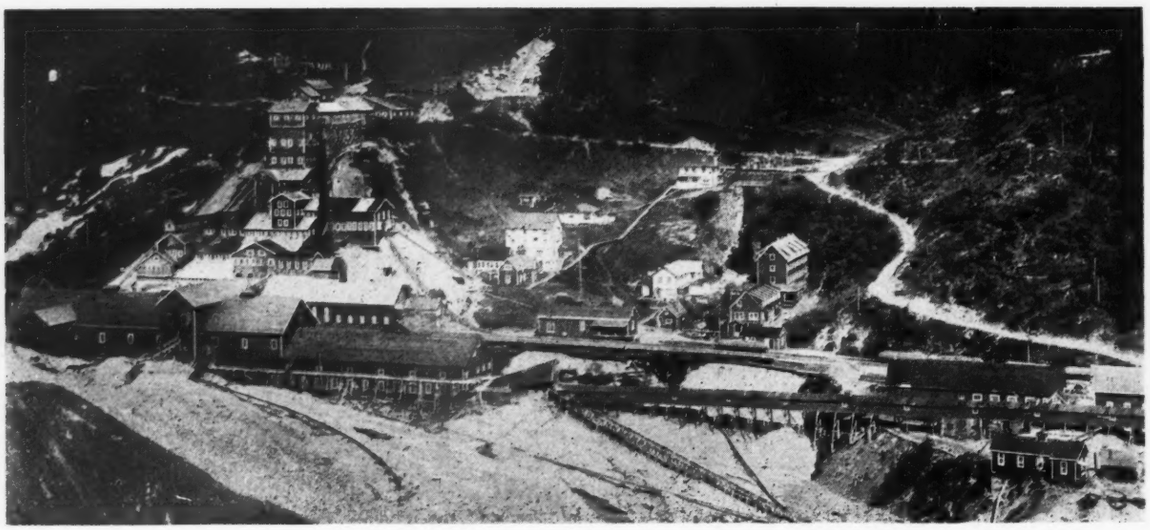
Standardization Movement Receives a New Impetus

TO BE ACCEPTABLE, a standard proposed for a particular industry must represent a true consensus of opinion in that industry. Time will be required to ascertain this—much more time, perhaps, than might at first seem necessary. Obviously, it is no petty task to determine the desirable characteristics of a standard and then persuade the competitive interests involved to agree as to its adoption. For this reason it is not surprising that the American Engineering Standards Committee progressed but slowly, despite the list of adopted standards to its credit. The slow advance of that organization was due in part also to the red tape that hampered its activities. To make matters worse, the Committee suffered from a lack of the funds that might have enabled it to get the results expected. The body has now been reorganized in an effort to speed its functioning. One hopes that its successor, the American Standards Association, will find a smoother path.

Despite the somewhat radical reorganization, the chairman of the Committee, Mr. W. J. Serrill, continues, it may be said, as president of the Association. Recently in Washington, at the convention of the American Mining Congress, Mr. Serrill discussed the transformation from old to new. He pointed out the chief defect of the Committee, as it was constituted—that its members were called upon to perform executive as well as deliberative and judicial functions; and, having been selected for technical knowledge, they served better in the latter capacity than in the former. These members, in the new body, constitute the so-called Standards Council, which has under its direction all technical problems connected with the approval of standards. A board of directors, not to exceed twelve in number, has been established, to determine the policies and undertake the Association's administrative work, in recognition of the fact that the standardization movement is one that interests the executives in industry and is not exclusively allied with the engineering departments of companies.

The change in name is interesting. "Committee," it was felt, was misleading, as indicating that the body was a secondary one, instead of being the leader in the standardization movement. Moreover, inasmuch as experience has shown that the standardization movement was largely a function of trade associations, the word "Engineering" was also dropped.

Whether or not the problem of securing sufficient funds has been solved only the future will determine. Raising money is never easy. According to Mr. Serrill, an income of not less than $150,000 per year will be needed for the proper conduct of the work. As he also points out, this is small in comparison with the savings possible as a result of the wider adoption of standardization.



Leaching plant and mill of the Kennecott Copper Corporation

FLOTATION *and* LEACHING

By E. J. DUGGAN

Mill Superintendent, Kennecott Copper Corporation, Kennecott, Alaska

THE Kennecott Copper Corporation is now operating two mining properties in Alaska, of which metallurgical operations of the Kennecott group will be discussed in this article. The Mother Lode mine, with its ground adjoining that of the Kennecott mines, is operated by the same organization, and its ore is treated in the Kennecott mill. Products of both plants are shipped to the American Smelting & Refining Company's smelter at Tacoma, Wash.

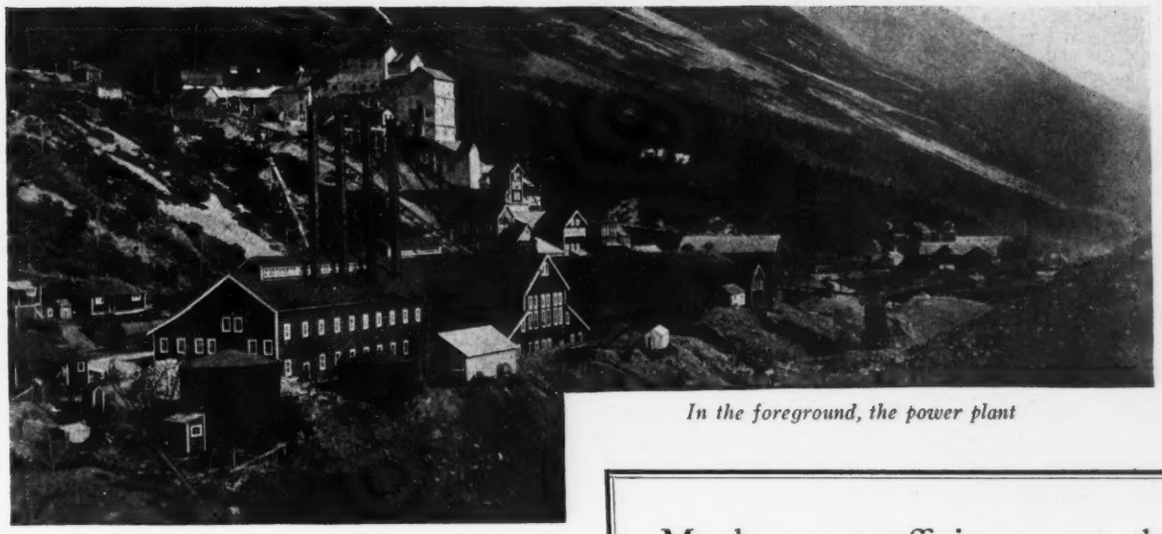
Kennecott is situated about 100 miles from the coast and is served by the Copper River & Northwestern Railway, which extends 196 miles from Cordova, the port of entry. The railroad right-of-way lies for most of its distance along the Copper River valley. This river is fed by many rather temperamental glacier streams, so that railroading in this country is accompanied by its own peculiar vicissitudes. As a consequence, freight rates are high, which fact has a direct bearing on every phase of operation. Shipping products must be held to as high a grade as possible, and, on account of the high cost of supplies, extraction processes cannot be carried to such lengths as if the mines were more favorably located.

The lower camp at Kennecott, where the mill, power plant, and main office are situated, is at an altitude of 2,200 ft. The mines, about 4 miles distant, are 3,500 ft. higher and are served by a system of aërial tramways. In this region the climate is not so rigorous as in other parts of interior Alaska, the temperature seldom dropping below —20 deg. F. There is an abundance of water in the summer, but during the winter months the supply to the mill drops at times to as low as 100 gallons per minute.

At present about one-third of the mine production is direct-smelting ore, the grade of which is held at 60 to 65 per cent copper, whereas the mill ore has a copper content of from 7 to 9 per cent. From 40 to 60 per cent of this copper occurs as malachite and azurite, the remainder being sulphide, mostly chalcocite with some covellite. All the copper minerals carry small amounts of silver. The gangue is a dolomitic limestone with small amounts of calcite. This would seem to be a direct-smelting ore, but on account of the high freight rates concentration is profitable, even with much lower recoveries than have ever been made.

The sulphides are easily recovered, being freed from the gangue by comparatively coarse grinding. Recovery of the carbonate offers the real metallurgical problem, and, as the calcareous gangue precludes acid leaching, an ammonia leaching plant was built to treat the discard

The Mother Lode mine at Kennecott



In the foreground, the power plant

at Kennecott

Much greater efficiency over the former all-leaching process has been secured by sulphidizing the finely ground carbonate ore and floating the concentrate

from the gravity concentrator. Operation of the leaching plant was begun in March, 1916, and an article by H. M. Lawrence describing the process was published in the *E. & M. J.* of Nov. 3, 1917. The treatment at that time consisted of gravity concentration followed by ammonia leaching. As the leaching plant was not designed to treat slime and fine sand, the minus-2-mm. material was screened from the mill feed and shipped direct to the smelter. Any slime made in grinding for concentration was tabled and discarded without further treatment. In 1921 the ore became more refractory, the carbonate content increased, and finer grinding was required to release the sulphide. In 1922 the gravity concentrator was remodeled to meet these changed conditions and the capacity was increased to 1,000 tons per day. Larger rolls were installed and more jigs and tables were added. The flotation plant for treating the copper carbonate slime was built in 1923, and as it then became more profitable to treat the fine material none has since been shipped direct. As a result of the finer grinding of the mill feed and the inclusion therein of the minus-2-mm. sizes, the leaching plant received an increased amount of fine sand, mostly too coarse for flotation. The effect was disastrous on leaching operations, as the fines tended to segregate, owing to imperfect distribution, causing channeling of the solutions and waste of steam through the leaching charges. Consumption of steam and ammonia increased 30 to 50 per cent while extraction dropped. With the flotation plant in operation, the solution of this difficulty was obvious, and in 1925 a fine-grinding unit was installed to grind these intermediate sizes to flotation feed.

The head of the Kennecott glacier

Practice in the Gravity Concentrator

The mill ore as delivered from the mines by aërial tramways is first crushed to 3 in. by 13x24-in. Buchanan jaw crushers. It is then hand-sorted, as much as possible of the carbonate being picked out to avoid subsequent slime losses. The ore is then crushed by a 36-in. Symons vertical disk crusher, followed by 54x20-in. Traylor rolls in closed circuit with trommel screens with 11-mm. round holes. All the screening in the mill was originally done by trommels. These are now being replaced by vibrating screens, which give a much lower operating and maintenance cost. Of greater advantage than cost, though, is the fact that they do not subject the ore to the crushing action of the trommels, with the resultant formation of copper carbonate slime. Undersize from the 11-mm. screens is again screened on vibrating screens with 1.3-mm. openings, the oversize from which is treated on jigs. The jig equipment consists of three 25-ft. Hancocks used as roughers and three 20x24-in. Woodbury Harz type jigs as cleaners. The green ore is fed to two Hancock jigs, the third Hancock treating all the middling. All three Hancocks produce rough concentrate, middling, and tailing. The cleaner jigs produce finished concentrate and middling. A considerable test has shown that the use of a rougher-cleaner

The aerial tram terminal just above the mill; in front of the mountains in the distance is Kennecott glacier

system has been of a decided advantage in the jig operation. The Hancocks may be operated with a looser bed, which is so essential to good jigging, and the cleaner jigs permit of closer control of the grade of the final concentrate.

Harz jigs were provided to treat the Symons crusher discharge before it was cracked in the rolls. The concentrate they produced was practically all sulphide, so their operation has been discontinued, as any sulphide slimed in grinding may now be recovered by flotation. Undersize from the 1.3-mm. vibrating screen is deslimed in a drag classifier. The classifier oversize is further classified by a six-spigot Richards vortex classifier, and the various spigot products are treated on eleven No. 6 Wilfley tables. The Wilfley middlings are treated on eight Plat-O sand tables and four James sand tables. All tables produce finished concentrates, middlings, and tailings. Overflow from the drag classifier (95 per cent minus 200 mesh) is settled in a two-tray Dorr thickener and treated on sixteen Plat-O slime tables. The slime constitutes the most refractory portion of the mill ore. It contains all the clay that comes from the mine, and as the carbonate minerals are softer than either the sulphides or the gangue, the proportion of carbonate copper in the slime is relatively high.

Table I—Assays and Recoveries for a Recent Month

	Per Cent Copper		Recovery Per Cent of Copper in Mill Feed		
	Total	Carbonate	Total	Sulphide	Carbonate
Mill feed	7.35	3.76	15.80	.....	8.73
Hand-picked ore	59.31	16.70	.....	.....	.....
Hancock jig feed	6.25	3.06	.....	.....	.....
Hancock jig tailing	0.74	0.64	.....	.....	.....
Hancock jig conc.	38.20	17.10	54.79	.....	48.02
Sand table feed	7.36	4.78	.....	.....	.....
Sand table tailing	1.90	1.71	.....	.....	.....
Sand table conc.	32.50	18.90	11.00	.....	12.58
Slime table feed	5.60	4.50	.....	.....	.....
Slime table tailing	4.10	3.85	.....	.....	.....
Slime table conc.	27.50	18.10	3.00	.....	3.84
Total gravity conc.	39.36	17.42	84.59	96.54	73.17
Ammonia Leaching Plant					
Head	0.74	0.64	.....	.....	.....
Tailing	0.25	0.15	.....	.....	.....
Precipitate	74.20	.....	4.21	.....	8.23
Per cent recovery, leaching plant heads	66.22	76.56	.....	.....	.....
Flotation Plant					
Head	3.00	2.73	.....	.....	.....
Tailing	0.75	0.70	.....	.....	.....
Conc.	30.15	27.20	6.71	1.33	11.87
Per cent recovery, flotation head	76.87	82.88	.....	.....	.....
Combined shipments	39.42	.....	95.51	97.87	93.27

The metallurgical results secured by the jigs and sand tables on this ore are notable. Practically all the sulphide freed in the grinding is recovered and a fair proportion of the carbonate. The jigs are handling a feed that ranges from 1 to 11 mm. and occasionally 13 mm. in

Table II—Assays of Jig Products, and Screen Analyses

	Per Cent Copper	
	Total	Carbonate
Nos. 1 and 2 Hancock (green feed)		
Feed	6.25	3.06
Rough concentrate	32.50	12.40
Middling	4.75	3.90
Tailing	0.60	0.51
Nos. 1 and 2 Cleaner Jigs		
Feed (Nos. 1 and 2 Hancock rough conc.)	32.50	12.40
Side draw	48.15	15.10
Hutch	51.22	17.25
Middling	6.80	5.31
No. 3 Hancock (all middlings)		
Feed	5.50	4.41
Rough concentrate	15.22	12.01
Middling	4.60	3.70
Tailing	0.79	0.67
No. 3 Cleaner Jig		
Feed (No. 3 Hancock rough conc.)	15.22	12.01
Side draw	24.10	16.60
Hutch	28.31	19.14
Middling	6.40	5.82

Screen Analyses

	Hancock Feed			Hancock Tailing		
	Per Cent Weight	Per Cent Cu		Per Cent Weight	Per Cent Cu	
		Total	Carb.		Total	Carb.
+9 mm.	4.1	4.97	2.74	3.9	0.59	0.51
+6 mm.	33.8	6.11	2.78	35.6	0.60	0.52
+2 mm.	50.3	6.25	2.87	45.6	0.76	0.67
+1 mm.	10.1	7.32	4.12	11.5	0.87	0.75
—1 mm.	1.7	7.55	6.20	3.4	1.47	1.25
Totals	100.0	6.26	3.01	100.0	0.73	0.63
	Table Feed			Table Tailing		
+ 14 mesh	3.0	5.51	2.74	2.5	1.37	1.22
+ 20 mesh	8.0	5 96	3.47	6.7	1.49	1.34
+ 35 mesh	24.0	6.03	3.68	23.1	1.72	1.54
+ 65 mesh	26.3	7.67	4.95	29.2	2.16	1.90
+100 mesh	16.0	8.06	5.51	18.0	1.71	1.49
+200 mesh	15.7	8.12	6.49	14.6	1.64	1.52
—200 mesh	7.0	7.95	6.31	5.9	1.61	1.48
Totals	100.0	7.23	4.88	100.0	1.80	1.60

size, thus eliminating the necessity of screening to intermediate sizes, and simplifying operations generally. They require little water; maintenance and operating costs are low; and they are simple to operate.

All of the jig tailing is sent to the ammonia leaching plant. The slime table tailing is dewatered in Dorr thickeners and floated. Sand table tailing may be either leached or reground and floated. The fine-grinding unit

consists of a 4x4-ft. ball mill in closed circuit with a drag classifier. The average percentage of tailings from the various departments is as follows: Jigs, 76; sand tables, 14; and slime tables, 10. Assays and screen tests for the various products are included in Tables I and II.

Few Changes in Leaching Process

The leaching process is essentially the same as described by Mr. Lawrence in 1917. Ammonia, or an aqueous solution of ammonium carbonate, is used as the lixiviant. Synthetic ammonia is purchased in a liquor containing 30 per cent NH_3, but this is converted to the carbonate on contact with the ore and is so regenerated in the evaporators. This is a solvent for the copper carbonate, forming double salts of copper and ammonium carbonate. The copper-bearing solution, after withdrawal from the ore, is boiled with live steam. This precipitates the copper as the black oxide and expels the ammonia in a vapor which is condensed and returned to the leaching circuit. The small amount of sulphide copper and the silver present, being insoluble in ammonia, are lost. A brief description of the plant and leaching cycle follows.

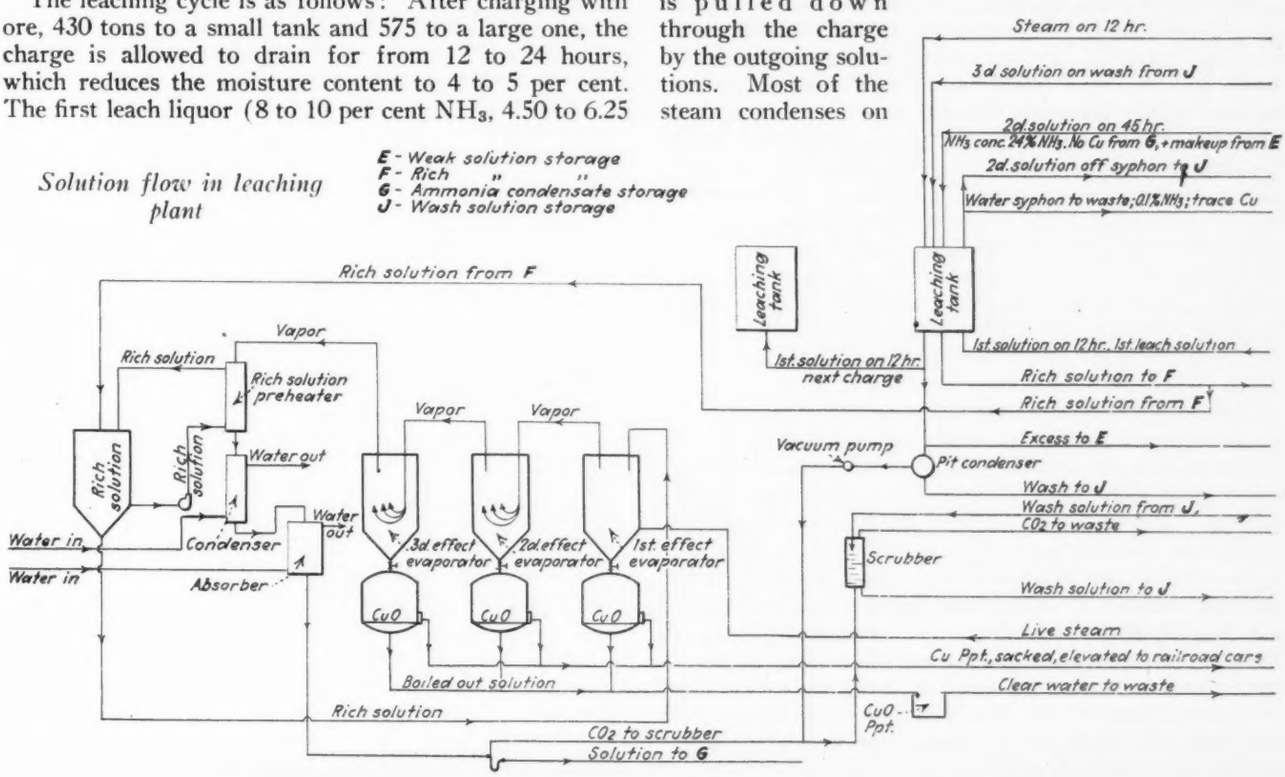
The Hancock jig tailing and some of the coarse table tailing comprise the feed to the leaching plant and average 0.80 to 1.10 per cent total copper, 0.70 to 0.90 per cent carbonate. This is dewatered in Esperanza drag classifiers, and is then fed by chain drag conveyors to the various leaching tanks. The classifier overflow, containing a small amount of slime, is sent to the flotation feed thickeners. There are eight leaching tanks each 30 ft. in diameter, four of them taking a charge 15 ft. deep, and the other four a charge 20 ft. deep. They are totally inclosed with dome-shaped vapor-tight tops and are equipped with mechanical excavators which also serve as distributors when running in reverse direction. They have false bottoms of discarded trommel screens, on which are placed coverings of cocoa matting and 8-oz. duck.

The leaching cycle is as follows: After charging with ore, 430 tons to a small tank and 575 to a large one, the charge is allowed to drain for from 12 to 24 hours, which reduces the moisture content to 4 to 5 per cent. The first leach liquor (8 to 10 per cent NH_3, 4.50 to 6.25 per cent Cu) is then pumped in from the bottom. (To simplify calculations all solutions are considered to have specific gravity of 1.) As this leach liquor rises through the charge, some of the residual moisture in the ore collects at the top of the rising solution column and is siphoned off to waste from the top of the charge. A small amount of ammonia and copper is lost in this way, but this loss is more than offset by the saving in steam which would ultimately be required to eliminate this water through the evaporators.

Some dilution of the leaching solution occurs, which accounts for the slightly lower ammonia content of the rich solution to the evaporators.

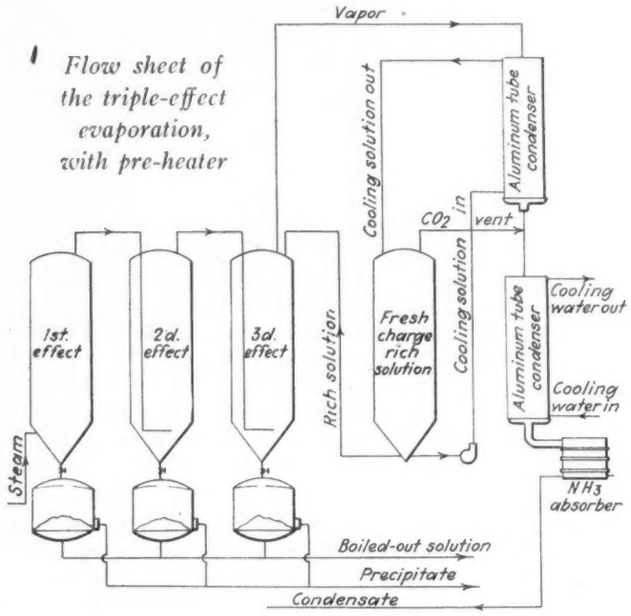
The first leach is allowed to stand for twelve hours, when approximately one-fourth of the solution on the charge is withdrawn and sent to the evaporators. This rich solution usually assays 5.8 to 7.2 per cent copper, 7.5 to 9.75 per cent NH_3, and 9.5 to 11.5 per cent CO_2, depending on the copper content of the feed. Solutions with more than 10 per cent NH_3 have been handled successfully. The ratio of NH_3 to copper is held at approximately 1.35 to 1, a lower ratio being unattainable on account of the high CO_2 content of the solutions. The rich solution which has been removed from the charge is then replaced with low-grade solution from storage (2 to 3 per cent Cu; 4 to 6 per cent NH_3) and ammonia condensate from the evaporators (24 per cent NH_3, 0 per cent Cu, 20 per cent CO_2), a sufficient excess of NH_3 being provided to complete the extraction of the copper. Fresh ammonia may also be added at this point to replenish the plant solutions as required. The solution is then circulated through the charge for about 45 hours, when it is pumped to the succeeding charge and becomes the first leach in the next cycle.

As the circulating leach is drawn from the tank it is followed by 20 to 22 tons of wash solution (1.25 to 2 per cent NH_3, 0.4 to 0.75 per cent Cu), which in turn is followed immediately by the steam wash. Live steam is admitted to the tanks at from 0 to 2 lb. pressure and is pulled down through the charge by the outgoing solutions. Most of the steam condenses on



Solution flow in leaching plant

the cold ore and functions as a water wash following the wash solution. After the charge becomes heated to the bottom, the effluent vapors are condensed in a water-cooled surface condenser, on which a vacuum of 8 to 10 in. of mercury is maintained by a Nash Hytor vacuum pump. Discharge from the vacuum pump is passed through a wood grid scrubber, which is sprayed with wash solution to remove the ammonia present, the excess CO_2 passing to the atmosphere. As in usual leaching



Flow sheet of the triple-effect evaporation, with pre-heater

practice, the last effluent solution from the tank and the steam wash condensate are pumped to weak-solution and wash-solution storage as plant needs require.

The whole success of the process depends on the steam wash. The steaming must proceed rapidly and uniformly through the entire charge, and a greater degree of permeability is probably required than in general leaching practice. This is effected by keeping all the slime and as much fine sand as necessary out of the charge, which class of material may just as well be treated by flotation. A water wash cannot be used, as the ore absorbs ammonia, which is liberated only by heat. The value of steam as a washing agent is demonstrated by the fact that a 575-ton charge which has been in contact with solutions containing as much as 10 per cent NH_3 is washed with 22 tons of wash solution (2 per cent NH_3) and 31 tons steam, so that the final effluent contains 0.10 per cent NH_3. There is little evidence of precipitated copper in the tailing, and the loss from this source is almost negligible.

The evaporators are essentially a steel cylinder 10 ft. in diameter by 16 ft. high, with a dome-shaped top and a 6-ft. cone at the bottom. A salt filter is placed directly under each evaporator. These are steel tanks with a cylinder 10 ft. in diameter by 5 ft. high, with a dome-shaped top and bottom. A false bottom of steel screen is placed near the bottom of each, on which is placed a filtering medium or burlap and twill. The evaporators may be operated in double, triple, or quadruple effect. They are being operated at present in triple effect, and the vapor from the third effect is being utilized to heat the incoming solution. Aluminum tube condensers and lead coil absorbers are provided for condensing and cooling the ammonia vapor.

Live steam is turned directly into the solution on first effect, the vapor from which flows directly into the solution on the next effect, and so on through the remaining effects. Vapor from the last effect coming from the freshest solution passes to the condensers. The condensers are arranged two in series, the first being cooled with rich solution and the second with water. The temperature of the fresh solution is thus raised to from 180 to 190 deg. F. while the three effects are held at 265, 242 and 220 deg. F. respectively. Action of the heat on the solutions is, first, the evolution of the CO_2 and NH_3 with the precipitation of the copper as a carbonate and hydrate. Steaming is continued until the solution is reduced to 0.01 per cent NH_3, by which time the copper has been converted to the black oxide, CuO. The evaporator contents are then forced by steam pressure into the salt filter, where the precipitate is collected and further dried by vacuum, the effluent going to waste. Precipitate which assays 75 per cent copper is shipped to the smelter.

The ammonia condensate assays approximately 24 per cent NH_3 and 20 per cent CO_2, considerable of the CO_2 being vented off from the absorber and wasted through the scrubber. As ammonium carbonate tends to crystallize out of the condensate at plant temperatures, it is necessary to dilute it with a small amount of weak solution to less than 20 per cent NH_3. The evaporators have never caused any trouble on account of crusts or accretions of copper precipitate. They are easy to operate, and the maintenance cost is low, although the steam consumption may be somewhat greater than in the continuous-column still.

Little trouble is now caused in the plant by corrosion. The condensers for the ammonia condensate are equipped with aluminum tubes and tube sheets, which have proved far superior to those of iron or steel. The condensate storage tank is lined with 2 in. of concrete, which provides what has proved to be ample protection from this corrosive liquor.

Merco Nordstrom lubricated plug valves are used wherever the service is severe, and they have saved considerable annoyance and expense. The flow of steam for the steam wash is regulated by hand, and to avoid the possibility of too great a pressure, with distortion or bursting of the tanks, a water seal is placed on each tank. This consists of a 7-ft. gooseneck of 3-in. pipe, which blows off at approximately 3 lb. pressure. A partial vacuum on account of an insufficient steam blow is prevented by a check valve, which consists of a steel box with a perforated bottom. A rubber disk 5 in. in diameter rests over these perforations and rises at a vacuum of $\frac{1}{4}$ in. mercury, admitting air to the tank.

The principal trend in recent practice has been to raise the grade of the leaching solutions, with a lessened volume of solution to the evaporators. There has been a reduction in the steam-washing time, and in the volume of steam required for washing, accomplished, as previously mentioned, by excluding the fines from the leaching plant feed. This effected a direct saving in steam and also reduced the dilution of the plant liquors, with coincident reduction in the amount of solution ultimately to be evaporated.

Triple-effect evaporation and preheating the evaporating solution decreased the steam consumption in the evaporators approximately 25 per cent and raised the grade of the ammonia condensate, another source of dilution of plant solutions. The reduction in the ton-

nage of solution evaporated has of course necessitated higher-grade leaching solutions, and these sometimes have an NH_3 content greater than 10 per cent. This increases the ammonia loss somewhat, but it is sound economic practice, as the cost of ammonia f.o.b. Kennecott has been dropping much more than the cost of steam.

Every effort is made to prevent dilution of the leaching solutions. The bad effect of water in the circuit is cumulative: it reduces the grade of the rich solution, which in turn reduces the grade of the ammonia condensate, which on return to the circuit causes further dilution of the leaching solutions.

Leaching plant data will be found in Table III.

Flotation Plant Treats Fine Copper Carbonate

After the construction of the leaching plant for the treatment of the coarse sand, the biggest problem remaining was the concentration of the copper carbonate in the fine sizes. As previously mentioned, the mill feed was screened at 2 mm. and the undersize was shipped to the smelter in a product assaying about 12 per cent copper (9 per cent carbonate copper). The small amount of slime and fine sand unavoidably made in grinding the rest of the mill feed was tabled and discarded. This procedure left much to be desired. The fine material shipped was not up to the requisite grade, and a considerable loss of carbonate copper occurred in the slime table tailing. An ammonia leaching process was developed in the laboratory for treating this class of material, in which the leaching and steam washing took place in a pressure filter. The construction cost would have been three or four times as much as the cost of a flotation plant of equal capacity, and efforts were then directed toward flotation.

Good recoveries were made with hydrogen sulphide as a sulphidizer, but the cost of the gas was high and it would have been dangerous and a nuisance to handle. Prior to 1922 consistent results had not been secured with sodium sulphide, and the experience of other plants using it for floating oxidized copper minerals was not encouraging. The correct combination was finally discovered. This proved to be a relatively large amount

Table III—Typical Leaching Cycle

Hours	
0– 12	Charging 575 tons ore, 0.82% Cu, 0.70% Carb., 6% H_2O
12– 24	Draining off 12 tons water
24– 32	Pumping into bottom 192 tons solution 8.2% NH_3, 5.0% Cu
30– 31	Syphon off from top 8 tons to waste, 0.10% NH_3, 0.07% Cu
31– 32	Syphon off from top 10 tons to wash storage 2.00% NH_3, 1.20% Cu
32– 44	Still leach.
44– 46	Pumping from bottom 55 tons rich solution to evaporators, 7.90% NH_3, 5.85% Cu
44– 46	Pumping on top 20 tons condensate 22% NH_3, 0% Cu
44– 46	Pumping on top 35 tons weak solution 5% NH_3, 3% Cu
46– 94	Circulating leach.
94–102	Pumping from bottom 192 tons to next charge
94– 96	Pumping on top 22 tons wash 1.70% NH_3, 0.75% Cu
96–108	Steam wash 31 tons live steam admitted to top
102–104	Pumping to weak solution storage 35 tons 5% NH_3, 3% Cu
104–108	Pumping to wash solution storage 12 tons 1.2% NH_3, 0.40% Cu
108–120	Discharging tailing 0.26% Cu, 0.14% Carb., 4% H_2O

Leaching Plant Data

Pounds NH_3 per ton leached	0.65
Pounds steam per ton leached (steam wash)	108
Pounds steam per ton leached (evaporators)	106
Pounds steam per ton leached (total)	214
Rich solution to evaporators, 7.90% NH_3, 5.85% Cu, 9.80% CO_2	
Boiled out solution, 0.01% NH_3	
Condensate, 23.1% NH_3, 18.5% CO_2	
Pounds steam per ton solution evaporated	1,040

of oils and a critical amount of sodium sulphide added preferably in stages, flotation to take place immediately after each addition. The plant was then built and put in operation in May, 1923.

The flotation equipment consists of eight mechanically agitated, single-spitz, Janney flotation machines. Of these machines, six in series are employed as roughers, and one is used for cleaning and one for mixing. These cells are all fitted with the short impeller shaft as developed in the Kennecott plants and require 4 hp. per cell. A thickener and Oliver filter are used for dewatering the flotation concentrate.

The feed to the flotation plant usually assays from 3 to 4 per cent copper, 90 per cent of which is carbonate. Sodium sulphide has always been used as the principal conditioning agent, although it was early found that calcium polysulphide in conjunction with the sodium sulphide gave improved recovery and grade of concentrate. This is formed by boiling one part quicklime with two parts ground sulphur.

A recovery of 72 to 75 per cent of the copper is obtained in a concentrate assaying 32 to 35 per cent copper. This recovery may be increased materially by lowering the grade of the concentrate, but such a procedure would be unprofitable, on account of the high freight rates. No special treatment is required to float the small amount of sulphide present, as it floats along with the carbonates. The various reagents are used in the following approximate amounts:

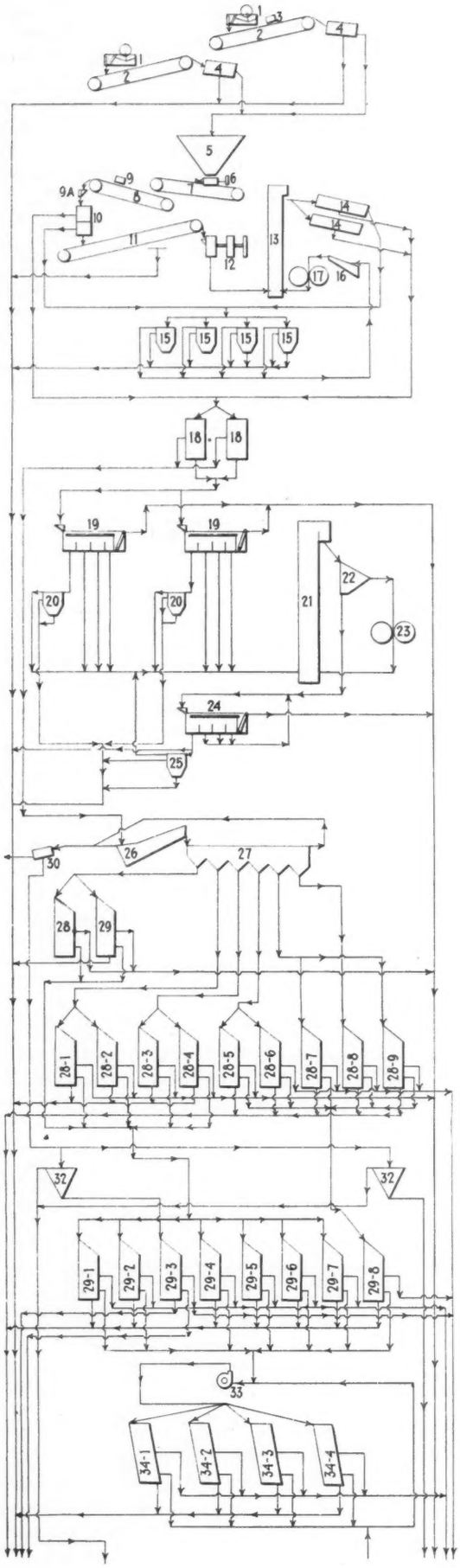
Flotation Reagents Used

	Pounds per Ton
Sodium sulphide	3.00
Sulphur	0.80
Quicklime	0.40
Coal-tar creosote	1.40
Steam-distilled pine oil	0.30

For the first few months of operation the sodium sulphide was added in small amounts to the various cells. Improvement by this method is much more decided when no calcium polysulphide is used. The objections to it are that the circuit is more difficult to control and that more cells are required to treat a given tonnage, as it virtually amounts to several successive flotations. As the possible benefit derived is small with calcium polysulphide in the circuit, the usual procedure is to add all reagents directly to the mixing cell. This provides all the time necessary for conditioning, as it has been found that more time is detrimental if anything. The froth is rather slow in forming, and more treatment is required than in the usual sulphide flotation.

Sodium sulphide functions as a sulphidizer of the carbonate minerals and as a deflocculator of the gangue. Calcium polysulphide is less active as a sulphidizer and is a flocculating agent for both the gangue and the mineral. However, in the presence of the sodium sulphide and in the concentrations of the two reagents usually employed, its effect on the gangue is not apparent.

The greatest loss of copper occurs in the slime portion of the tailing. As all the coarse sand goes to the leaching plant, a concentration of slime occurs in the flotation feed, and the amount of colloidal material is much greater than if the flotation plant were receiving run-of-mine feed. This condition was aggravated when, in 1924, the minus-2-mm. material formerly shipped to the smelter was included in the mill feed. The slime made incidental to grinding the coarse material for concentration is practically all limestone, whereas the slime from the mine contains more or less "insoluble," in the form of alumina and oxidized iron. The most pernicious of these is probably the oxidized iron, although the slime loss is high when treating clean limestone ore too. The inclusion of the primary or mine slime in the feed caused a net loss of 5 to 10 per cent in the flotation recovery, and no remedy for this condition has so far been found. Flow sheet and legend follow on p. 1014.



Legend

1 2 Buchanan jaw crushers—Size 13x24 in.; r.p.m., 250, opening 3½ in.

2 2 conveyors { Jumbo—Length 209 ft., width 22 in., 5 ply / Bonanza—Length 196 ft., width 22 in., 5 ply

3 1 cobbing magnet

4 2 trommels (Jumbo and Bonanza). Each 9 ft. long, 4 ft. diam., 2-mm. opening, 1¼-in. slope per foot; of punched plate

5 1 ore bin, available capacity, 400 tons, max. width, 32 ft., max. length, 32 ft., max. depth, 20 ft.

6 1 Stevens-Adamson apron feeder

7 1 conveyor—length, 40 ft., width, 32 in., 5 ply; 60 ft. per minute

8 1 conveyor—length, 52 ft., width, 32 in., 5 ply; 60 ft. per minute

9 1 cobbing magnet

9a 1 Vezin head sampler

10 1 trommel—diameter, 4 ft.; 27 in.; 11 mm.; 30 in., 1 in. mesh; r.p.m. 16

11 sorting conveyor—length, 40 ft.; width, 32 in.; 5 ply; 50 ft. per minute

12 Symons crusher—size 36 in.; oscillations, 335; r.p.m., 135; opening, 1 in.

13 2 elevators—length, 58 ft.; width, 18 in.; 10 ply; 380 ft. per minute; 54 cups

14 2 trommels—diameter, 4 ft.; length, 9 ft.; r.p.m., 18; punched plate with 11 mm. openings

15 4 Bull Jigs

	Stroke, Inch.	R.P.M.	Screen
No. 1	2¾	189	9 mm.
No. 2	2	194	9 mm.
No. 3	not running		9 mm.
No. 4	not running		9 mm.

16 Drag dewaterer—length, 32 ft.; width, 32 ft.; chain No., 823; slope, 6½ in. in 12 in.; 45 ft. per minute

17 Traylor rolls—size, 54x20 in.; r.p.m., 83

18 2 trommels—diameter, 4 ft.; length, 9 ft.; r.p.m., 15; punched plate with 1¼-mm. openings

19 2 Hancock jigs each

R.P.M.	Lift, Inch	Throw, Inch	Depth of Pocket, Feet	Width of Pocket, Feet
195	⅛	⅜	3½	3⅝

Screens										
Inches of screen	15½	35	10	25	20	15	25	15	40	20½
Total 221 in.										
Size in millimeters	4	6	9	13	6	13	6	13	4	6

20 2 single hutch Harz jigs; r.p.m., 265; stroke, ¾ in.; 4-mm. screen

21 1 elevator—length, 50 ft.; width, 18 in.; 10 ply; 400 ft. per minute, 48 cups

22 1 Colorado impact screen—size, 3x3 ft.; No. of impacts, 324; size of opening, 2½ mm.; slope, 22 deg.

23 1 set Traylor rolls—size, 36x16 in.; r.p.m., 125

24 1 Hancock jig,

R.P.M.	Lift, inch	Throw, Inch	Depth of Pocket, Feet	Width of Pocket Feet
No. 3 195	⅛	⅜	3½	3⅝

Screens										
Inches of screen	68½	9	22½	9	27	18	13½	18	18	18½
Total 222 in.										
Size in millimeters	4	9	4	13	4	9	13	9	6	4

25 1 2-compartment Harz jig; r.p.m., 265; stroke, ¾ in.; 4 mm. screens

26 1 drag dewaterer—length, 32 ft.; width, 30 in.; chain No. 830; slope, 3¼ in. in 12 in.

27 1 Richards hindered settling classifier: No. of spigots, 6; water head, 30 ft.

28 1 Wilfley table: stroke, 1⅛ in.; slope, ¾ in. 12; r.p.m., 258

29 1 Plat-O table: stroke, 1⅛ in.; slope, 1¼ in. 12; r.p.m., 304

30 1 Chip Trommel—length 5 ft.; diameter, 3 ft.; r.p.m., 16; screen, 4-mm. opening

28 9 Wilfley tables—

	R.P.M.	Slope Per Foot Inches	Stroke, Inches
28—1	256	13/16	3½
28—2	270	7/8	1
28—3	248	5/8	⅞
28—4	276	5/8	1 1/16
28—5	258	13/16	1 1/16
28—6	257	15/16	1 1/16
28—7	259	13/16	15/16
28—8	256	13/16	15/16
28—9	260	13/16	⅞

29 8 Plat-O tables—

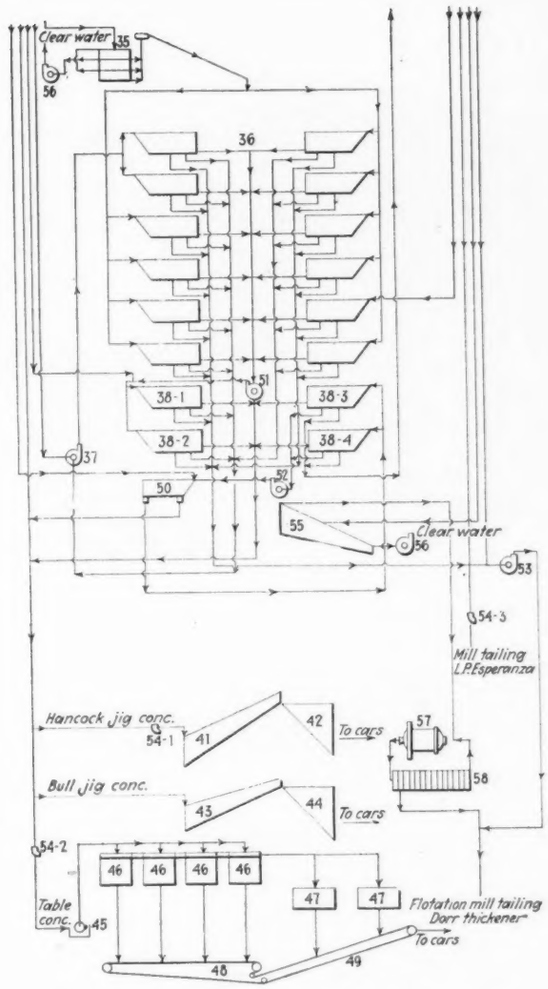
	R.P.M.	Slope Per Foot, Inches	Stroke, Inches
29—1	335	9/16	⅝
29—2	335	9/16	⅝
29—3	335	1/2	⅝
29—4	261	1/2	⅝
29—5	320	1/2	⅝
29—6	262	13/16	⅝
29—7	315	9/16	⅝
29—8	318	9/16	⅝

32 2 8-ft. Callow cones

33 1 2-in. Wilfley centrifugal pump

34 4 James tables—

	R.P.M.	Slope Per Foot, Inches	Stroke, Inches
34—1	245	3/8	3/4
34—2	247	3/8	3/4
34—3	230	3/8	3/4
34—4	230	3/8	1 1/16



Flow sheet of the Kennecott concentrator

35 1 2-tray Dorr thickener—diameter, 20 ft.; height, 16 ft.
36 12 Plat-O slime tables each 305 r.p.m.; ¼-in. slope per ft.; ⅜-in. stroke
37 1 48x6-in. Frenier pump
38 4 Plat-O slime tables

	R.P.M.	Stroke, Inches
38—1	305	⅜
38—2	305	⅜
38—3	280	½
38—4	280	½

39 1 conveyor—length of belt, 170 ft.; width, 16 in.; 5 ply; 100 ft. per minute
40 1 3-compartment bin; capacity, 350 tons
41 1 drag dewaterer—length, 26 ft.; width, 40 in.; slope, 3½ in. 12; 12 ft. per minute
42 1 bin—capacity, 110 tons
43 1 drag dewaterer—length, 26 ft.; width, 14 in.; slope 3½ in. 12; speed, 12 ft. per minute
44 1 bin—capacity, 140 tons
45 1 Frenier pump, 48x6 in.
46 4 table concentrate tanks, diameter 9 ft.; height, 5 ft.
47 2 table concentrate tanks, diameter 11 ft. 6 in.; height, 5 ft.
48 1 conveyor—length, 25 ft.; width, 22 in.; 5 ply; 14 ft. per minute; slope, 5½ in. in 12 in.
49 1 conveyor—length, 25 ft.; width, 22 in.; 5 ply; 14 ft. per minute; slope, 5½ in. 12 in.
50 1 2-spigot classifier
51 1 Frenier pump, 48x6 in.
52 1 2x9-in. centrifugal Byron Jackson pump
53 1 4-in. centrifugal Wilfley pump
54 3 Galligher samplers
55 1 drag dewaterer
56 2 2-stage, 3-in. Moran centrifugal pumps
57 1 ball mill—4x4 ft., r.p.m., 30
58 1 36-in. Esperanza classifier.

The following analysis of feed and tailing is typical:

Screen Analyses of Flotation Feed and Tailing

	Per Cent Weight	Per Cent Cu, Feed	Per Cent Cu, Tailing
+ 65	2.0	1.80	0.90
+100	9.3	1.75	0.55
+150	7.9	1.82	0.45
+200	10.1	2.10	0.49
+275	7.3	2.12	0.45
+325	3.4	2.55	0.40
—325 sand	41.0	3.40	0.41
Slime	19.0	4.65	2.20
Total and average.....	100.0	3.08	0.80

The slime portion is determined by dispersing the wet pulp with sodium sulphide and sodium silicate and decanting off everything remaining in suspension after ten minutes. The slime is of an entirely different chemical composition than the sand, which is practically all limestone. It carries from 12 to 20 per cent "insoluble," 8 to 16 per cent Al_2O_3, and 6 to 12 per cent oxidized iron, plus limestone and copper carbonate.

A critical amount of sodium sulphide is required for any given feed, depending on the amount of slime and the copper content. Amounts much in excess of this are harmful, probably owing to the increased causticity of the pulp. Highest recoveries are still made in the laboratory with hydrogen sulphide gas and either sodium sulphide or caustic soda as deflocculators. The favorable results secured by this circuit are probably attributable to the fact that sufficient sulphidizing agent can be added to float the refractory slime without at the same time increasing the alkalinity of the pulp to a point where flotation is inhibited. This circuit is impracticable, on account of the high cost of the hydrogen sulphide gas.

As the slime in the concentrate is in a deflocculated condition, a neutralizing agent such as epsom salts or calcium chloride must be used. Otherwise the thickener overflow is dirty and the filter cake is wet and sticky.

The flotation plant has been a decided commercial success since its inception and now occupies a more important position in the system than the ammonia leaching plant. However, it has not completely solved the problem of the treatment of the fine material, and the high copper content of the slime discard remains the biggest stumbling block to materially greater recoveries.

The question now arises: Why not treat all the gravity concentrator discard by flotation, thus simplifying the flow sheet, with a probable reduction in costs and an increase in recovery? A recent plant test indicated this possibility, as a recovery of 97.5 per cent was made by gravity concentration followed by flotation from an ore assaying 8.28 per cent copper (3.09 per cent carbonate). The cost of remodeling the plant as well as the shortage of water during the winter months militate against the adoption of this process. Leaching plant tailing is discarded with a moisture content of less than 5 per cent, which would be impossible to duplicate with a flotation tailing. The principal advantage of the leaching process is that its product has a copper content of about 75 per cent; its drawback is that it recovers none of the sulphide copper and silver and is not adapted to the treatment of slime. According to laboratory results, all-flotation will effect practically the same recovery of the sulphides with or without previous gravity concentration. This is not true of carbonates, as the carbonate content of the flotation tailing and the consumption of reagents vary with the carbonate in the feed.

Feed to the mill, which is 3-in. material, is sampled by ordinary Vezin samplers in three cuts, with crushing between each cut. Galligher and Scoby samplers are used for the other products.

Power is generated for both mine and mill by two 6-cylinder, 600-hp. McIntosh & Seymour Diesel engines, each direct-connected to a 600-kva. Westinghouse a.c generator, and a Westinghouse steam turbine direct-connected to a 1,250-kva. generator. Steam for the turbine, leaching plant, and steam heat system is supplied by four Erie City 300-hp. water-tube boilers. California residuum is used as fuel for both Diesels and boilers.

Abstract of a paper prepared for the Canadian Institute of Mining and Metallurgy

By FRANK D. ADAMS
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Occurrence .... Mining... and Concentrating o

THE greatest tin-mining district of the world extends from Burma southeasterly through Siam, the unfederated Malay states, the Federated Malay States, the Straits Settlements at the point of the Malay Peninsula, and on into the Malaysian archipelago, especially some of the islands of the Dutch East Indies. In this stretch of country about two-thirds of the world's tin is produced, most of the other third coming from Bolivia. Of the various political divisions, the Federated Malay States is the most important as a producer of tin, being the source of one-third of the world production.

The Malay Peninsula is an area of low-lying land with a skeleton of mountain ranges running more or less obliquely to its longer axis. These ranges are not continuous but succeed one another *en echelon;* they are caused by the folding of the earth's crust and they usually have a granite axis. The Mesozoic granite which forms the axis of one of them known as the Main range, and which can be followed through the Dutch islands of Singkep and Banka, was the source of mineralization which has given rise to the greatest tin deposits of the world. Of ten of these great anticlinal folds, the granite axis in seven is known to be tin-bearing. The Kinta district, situated between two of these granite masses—the Kledang range and the Main range —is the richest tin field in the peninsula.

Tin occurs in Malaya, as almost everywhere else in the world, as cassiterite, or oxide of tin. This ore, wherever found, is, almost without exception, associated with granite or with some closely allied highly acid igneous rock. In Malaya it is associated with intrusions of granite.

The tin in Malaya may be said to occur in four ways:

1. Primary ore, as stockworks in granite and associated rocks.
2. Primary ore, occurring as pipes in crystalline limestone or in granite.
3. Residual deposits, formed by the deep-seated decay of granite and associated rocks, the tin ore still remaining *in situ.*
4. Alluvial or secondary deposits derived from the foregoing and laid down in water.

The amount of tin ore in the ground treated is usually low. In the alluvial and residual deposits it is stated in *kati* per cubic yard—a *kati* being 1⅓ lb. Twenty-five years ago a property containing one *kati* per cubic yard was considered to be very poor; now such a property is regarded as rich, and half a *kati* per cubic yard can be profitably worked by dredging—which is roughly

Fig. 2—Beatrice mill, and surfac

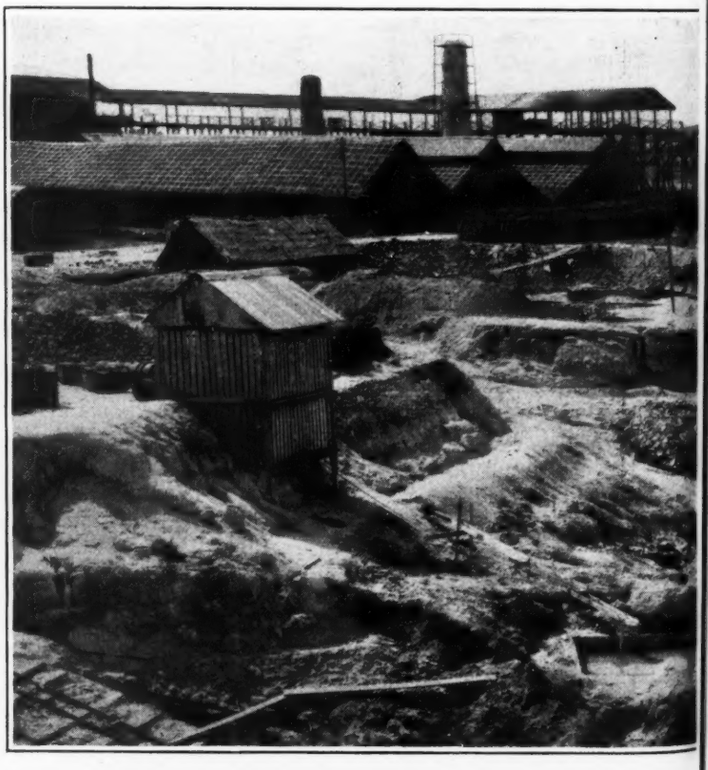


Fig. 1—The Nam Koong Kongsi open-cast working, near Ipoh

g *of* MALAYAN TIN

0.015 per cent of tin ore in the ground treated. In stockworks or lodes, which must be mined and milled, a larger return—about 2 per cent—is required for profitable mining unless a very large output can be maintained and power is cheap.

The tin mining is carried on chiefly by the Chinese. These astute and hard-working people have for very many years been coming southward into Malaya and engaging in all branches of trade and industry. It is certain that Chinese have known and worked the tin deposits of the Malay Peninsula for several hundred years. Although European capital and modern methods of working have become increasingly important, mines under Chinese management are still important producers. Practically all the propecting for tin ore is done by the Chinese and Malays with the assistance of the native aborigines and the Chinese also supply almost all the labor in the tin mines operated under the management of Europeans.

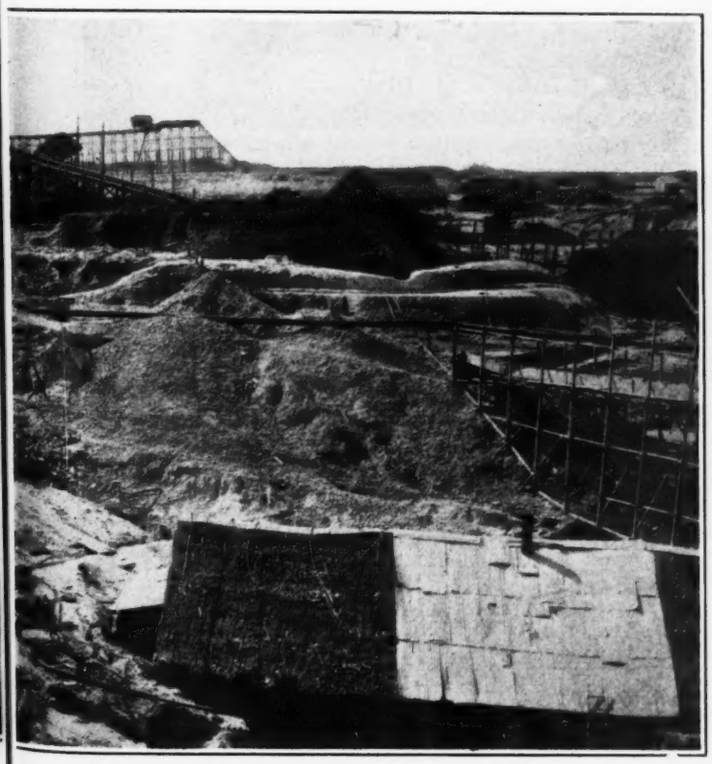
In the northern part of the Malay Peninsula, near the Siam border in northern Perak, is a tin area of importance wherein are situated the properties of the Rahman Hydraulic Tin Company, Ltd., and the Hitam Tin Mines. Further south, near the center of the state of Perak, is the Kinta district, which, though only 36 miles long and with an extreme width of 25 miles, produces half the tin of British Malaya.

Although tin ore sometimes occurs in stockworks in the granite, the tin ore of the Kinta district, when found *in situ* in solid rock, is usually in the form of pipes. These may occur either in the granite or in the limestone, and are almost invariably near the contact of these two rocks. These pipes are, as the name implies, vertical or steeply dipping orebodies with an approximately elliptical cross-section. The maximum width of these pipes is about 40 ft., but they have been followed down to considerable depths, the Lahat pipe having reached a depth of 340 ft. still in ore, when working was discontinued on account of heavy pumping charges. They are worked by sinking a shaft on the orebody and removing it *in toto* as the shaft is deepened.

These pipes are clearly formed by the tin-bearing vapors or solutions, given off by the granite as it cools, forcing their way along lines of weakness, through the upper already solidified portion of the granite or into

and

surface workings of the mine



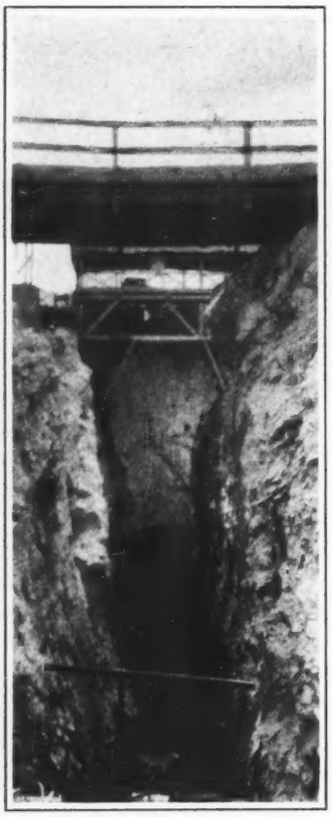


Fig. 3—Looking down the slope of the Beatrice mine

the overlying limestone. These vapors or solutions, containing fluorine and boron compounds, attack the granite and limestone and, by chemical reactions set up with the constituent minerals of these rocks, produce, in addition to the cassiterite, a series of new minerals characteristic of these pipe-deposits, as follows:

In the Pipes in Granite

Tourmaline is abundant.
Tremolite not found.
Fluorite not common.
White mica is found where ore is rich.
Metallic sulphides are not abundant.

In the Pipes in Limestone

Tourmaline rare.
Tremolite common.
Fluorite common.
Little white mica or lepidolite.
Metallic sulphides abundant.

Although these two groups of minerals are distinctly different, they were in all probability both formed by vapors having the same composition, the diversity being due to the divergence in composition of the rocks traversed. Thus tourmaline is a mineral containing aluminum, an element which is abundant in the granite but absent in the limestone, and hence it is not found in the pipes traversing this latter rock. Tremolite, being a silicate of lime and magnesia, takes these bases from the limestone, in which they are abundant, while in the granite they are present only in very small amount. The same reason accounts for the distribution of the fluorite.

The Beatrice mine, which may be selected as a type of this class and which is the richest of all the pipes in these limestones, is situated at Selebin, a village about two miles northwest of Ipoh. This pipe differs from others in the district in that at the surface it was not vertical in position but dipped at a gentle gradient of 1 to 4. When it had been followed down this slope for a distance of over 700 ft. it became vertical, and in November, 1927, the workings had reached a depth of 250 ft. from the surface. It is lenticular in cross-section, measuring 40x10 ft. The slope running down on the orebody, with its system of wire-rope haulage and provided with a long flight of steps, as it appeared in January, 1927, is shown in Fig. 3. This high-vaulted slope required no timbering. The mine is lighted by electric arc-lights, and, when visited, some fifty Chinese miners, sitting close together at the bottom of the slope, were each engaged in drilling a separate hole by hand, the impact of the fifty hammers on the drills in the restricted area giving rise to a deafening din.

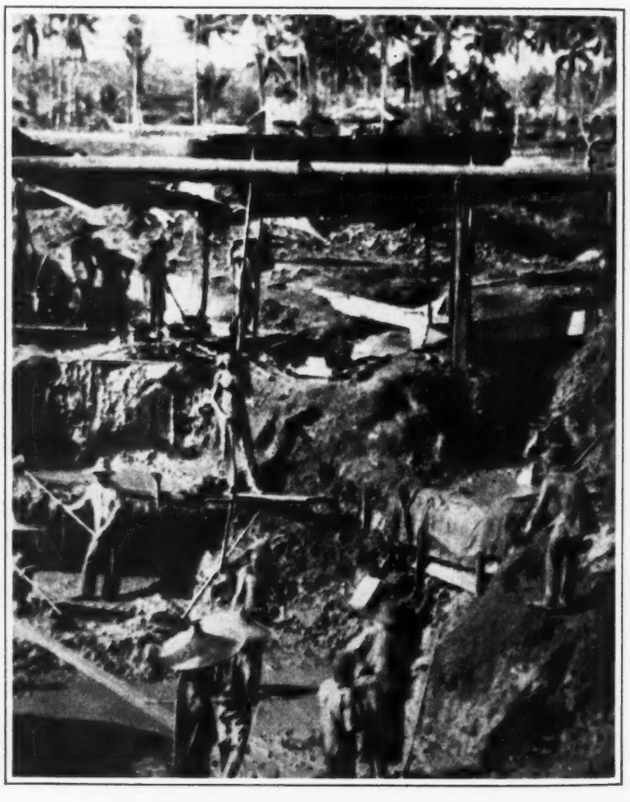
The ore is rich, running from 12 to 20 per cent of cassiterite, or from about 10 to 16 per cent of elemental tin. It is taken from the mine to the mill (see Fig. 2) where it is crushed to 2 in. and passed under stamps. The fines are washed in sluice boxes ten times, dried, calcined in furnaces to get rid of the arsenic and sulphur, and then passed over magnetic separators and re-washed six times.

This pipe was discovered in July, 1923, and has been worked by a Chinese company, which has a long lease of the property, for which it pays a trifling sum. This company started with a capital of £468. Between September, 1923, and August, 1926, 3,360 tons of tin ore were recovered, giving a profit of £233,182, and there is every prospect of similar yields in the future.

The heavy tropical rainfall has weathered the rocks so that limestone has a cavernous and uneven surface, the granite has become a mass of quartzose clay, and the schists have altered into a variety of characteristic products. The residual deposits have been washed down into the limestone caverns, and alluvial flats have been formed on the floor of the present valley, which are being eroded by the present streams. These residual and alluvial deposits retain all the tin which was present in the rocks from which they were derived.

In working, no distinction is made between the residual and alluvial deposits. They are often intimately associated and can be worked together and by the same methods. They are opened up by great excavations known as *lombong,* which, when carried below the water level, have to be kept dry by bailing or pumping. In dealing with water, the Chinese show great ingenuity. In small excavations, the water is raised from two to six feet by two men standing facing one another about twenty feet apart on either side of the excavation, each holding the ends of two cords attached respectively to the ends of a kerosene can which is suspended halfway between them (see Fig. 4). By a deft swaying motion to and fro on the part of the men, this can is swung down into the water, filled and then swung up to the top of the embankment and emptied, the movement being carried on continuously and without any intermission

Fig. 4—Chinese working an alluvial tin deposit



for periods of rest until the pool is emptied.

If the water has to be raised from greater depths, of say, fifteen feet, a balance-pole with a bucket at one end is often employed. In still deeper excavations the *kincha,* or Chinese chain-pump, operated by a water wheel or treadmill, is used. This consists of an endless chain of wooden links, each with a rectangular drag some 5 in. wide and 10 in. deep, traveling up an inclined trough

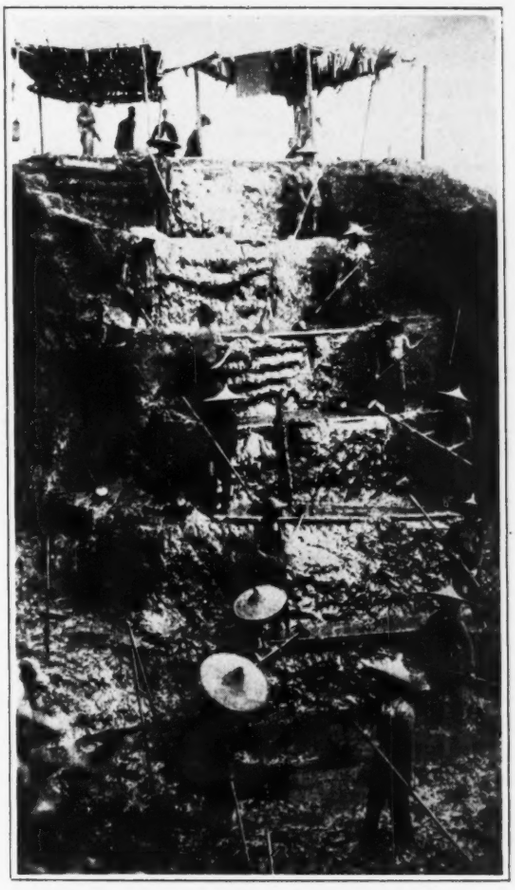


Fig. 5—Chinese method of elevating tin-bearing clay mixed with water

usually set at an inclination of about 30 deg. to the horizontal. This is a cheap and fairly efficient pumping apparatus.

Another method which is employed for raising water, or the tin-bearing clay mixed with water, is to cut a series of notches on the side of the excavation, on each of which a man stands with a small ladle-like bucket on the end of a pole with which he scoops up the clay and water and throws it over his shoulder into the depression in front of the man next above him, who repeats the same operation, and so on until the surface is reached (see Fig. 5). These simple methods are still used in the smaller and shallower excavations, but in recent years, for deeper workings, all varieties of modern pumping machinery have been installed, both by the Chinese and the European operators, steam-driven centrifugal pumps being chiefly favored. For removing the large amount of ground which has to be handled

Fig. 7—Hydraulic elevators at the Gopeng Consolidated mines

in open-cast mining, coolies are employed who carry the material in two buckets suspended from the ends of a springy shoulder stick. These move in endless processions and eventually can remove mountains.

An interesting open-cast mine of this type, in which the general character of the deposits and the methods of working on a large scale are well seen, is the Nam Koong Kongsi, near Ipoh, owned by a wealthy Chinese gentleman. This is a typical alluvial deposit and is shown in Fig. 1. The alluvium lies in a valley between the Kledang granite on the left and the white crystalline limestone on the right, which latter is being laid bare by the workings. The upper surface of the alluvium is seen in the terrace level on the left. This alluvium has been washed away to a depth of 140 ft. and has been penetrated by shafts or borings to a further depth of 100 ft. without reaching the bottom of the deposit, which is richer in tin at this depth than at the level of the present workings. The granite is deeply decomposed, but where it is seen in a fresh condition is traversed by a network of little veins, giving it the appearance of a stockwork.

In working this alluvium, water is brought down from the adjacent mountains and delivered by monitors (seen in the foreground on the right in Fig. 1, against the alluvium overlying the limestone). These monitors were first employed in this district in 1902. The wash from the monitors runs down into the sump, situated in front of the buildings in the bottom of the valley in the middle distance, and from this, the water

Fig. 6—A portion of the Gopeng Consolidated property, with a monitor at work

and gravel, the latter up to a man's fist in size, is pumped to the top of the high framework of poles seen on the right and known as a *palong;* two of these are seen side by side. The rotary pumps—two in number—by which this material is raised are set in a strong concrete platform in the buildings referred to above and are run by a 120-hp. Fairbanks - Morse oil-engine. The pumps raise the water, and wash which it contains, to a height of about 120 ft. Certain parts of these pumps, as well as a portion of the piping, naturally wear away rapidly, some parts of the lining of the pump requiring to be renewed every three days. These parts are cast in the foundries at Ipoh.

Fig. 8—Launder on one of the "palongs" of the Lahat mine

These pumps not only raise material to the top of the *palong,* but in so doing aid in further disintegrating the alluvium and pulping it up with the water. At the top of the *palong* it is poured into the upper end of a long, gently slanting sluice box, which is built on top of the framework and runs down its whole length. While running down this sluice, the material is raked over by coolies, with long-handled hoes, and a rough concentration of the cassiterite is thus effected. This will be referred to again. Three hundred coolies are employed, and the mine produces about sixteen to seventeen tons of tin ore per month from gravel which contains on an average one *kati* of cassiterite per cubic yard. This yields a profit, but a still larger profit is expected when the deeper and richer alluvium which lies nearer the bedrock is reached.

Another mine of this class is the Gopeng Consolidated, which is one of the richest alluvial workings in Malaya and the largest tin mine of its kind in the world. The company's property embraces an area of over 3,000 acres. Tinstone has been found in the granite, in the schists and in pegmatite dikes cutting the limestone. The alluvium has an average thickness of about 100 ft. Tin ore is distributed throughout this alluvium and is not necessarily more abundant toward the bedrock than elsewhere. The alluvium holds about 1½ lb. of tin ore to the cubic yard and produces a little less than 1,000 tons of tin ore per year. Fig. 6 shows the appearance of the workings, with a monitor undercutting the alluvium on the right. The main pipe line which supplies water to the monitor brings this from the granite hills of the Main range seven miles distant.

The ground thus broken down by the monitors is raised by great hydraulic elevators, worked by a powerful jet of water under a pressure of 160 lb. per square inch, which carry it up a pipe to a height of 80 ft. and deliver it to the launders on the top of the *palong* as shown in Fig. 7. The appearance of such a launder, on one of the Lahat Mine *palongs,* is shown in Fig. 8, where the Chinese workmen in the launder are keeping the material, which is being washed, moving down the slope.

These sluice boxes or launders in the Gopeng Consolidated mines are 350 ft. long with a slope of one in fifty, and about 7 per cent of the tin ore escapes from them. A Chinese tributer takes over all the tailings and rewashes them with a gang of about one hundred coolies, recovering about seven-eighths of this ore, of which he gives the company 60 per cent as their share, keeping 40 per cent for himself.

The appearance of the coolies who furnish all the labor in and about the Kinta district will be seen in the illustration at the top of the first page of this article.

The management of the Gopeng mines estimates that they have material to work upon at current rates of output and price for something like seventy years.

Tin Ore in Alluvial Deposits Worked by Dredging

Tin dredging in Malaya is being rapidly developed and it is stated that forty dredges will soon be in operation. This method of winning tin ore is chiefly employed in low and swampy lands.

The largest of these dredging operations, in fact the largest tin-dredging enterprise in the world, is that of the Malayan Tin Dredging Company, Ltd., which works an area of lakes and swamps near Batu Gajah. In January, 1927, the company had five dredges working on this property and two more on another area, and was engaged in building others, which, when completed, would bring the number of dredges in operation up to ten in all. Mr. A. J. Kelman, the manager of the company, informed me that the ground which was being worked held 0.6 lb. of cassiterite to the cubic yard, and that borings made by the company showed that the lower levels of the deposits contained about 0.5 lb. per cubic yard. He believes that the deposit, speaking generally, is about equal in richness from top to bottom. In the opinion of others, this probably does not hold in all the areas of dredging ground in the district, in which, as a general rule they are rather richer toward the bottom. This point, however, is not definitely settled. As the cassiterite in these deposits is usually in small grains, and the deposits have been laid down by the deposition of successive layers of wash carried down in times of flood, during which the underlying beds have apparently

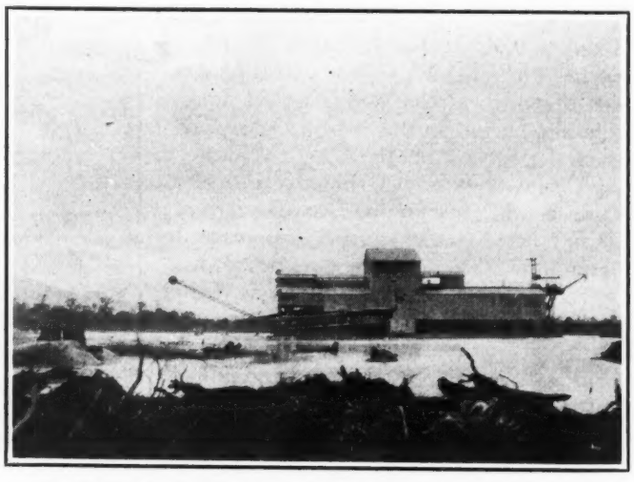


Fig. 9—No. 5 dredge of the Malayan Tin Dredging Company, Ltd.

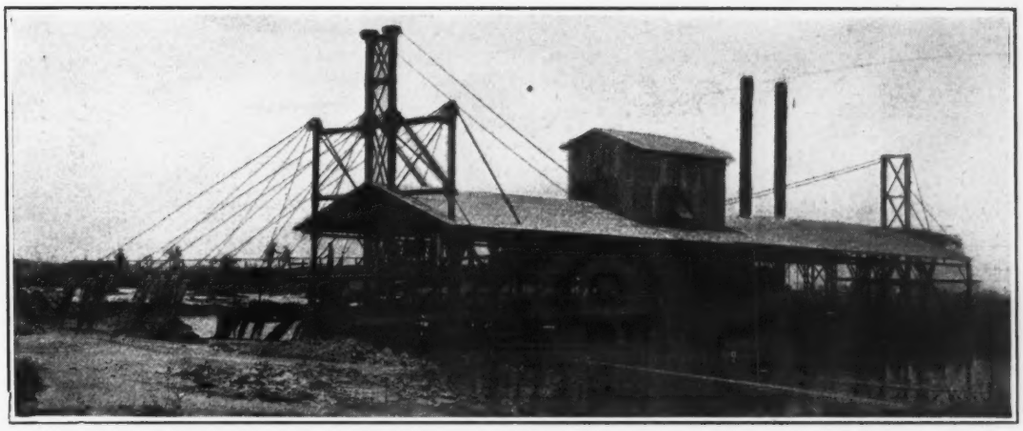


Fig. 10—No. 4 dredge of the Malayan Tin Dredging Company, Ltd.

not been to any considerable extent disturbed and reassorted, the tinstone might well be distributed through the alluvium in thin successive layers rather than showing a heavy concentration on the bedrock.

One of these dredges (No. 5) is shown at work in Fig. 9. It is a bucket dredge and is working to a depth of 65 ft. In some cases the material is raised from a still greater depth if the distance to bedrock requires it. The dredge raises about 150,000 cu.yd. per month.

The material brought up by the buckets is thrown immediately into a revolving trommel. All the tin ore passes though the holes with the water, while the coarse material passing down the trommel is barren and goes back into the lake. From the trommel the ore passes to a series of jigs, which give concentrates holding 30 per cent of cassiterite. These concentrates are then taken ashore and washed about a dozen times in succession in a series of slanting troughs, being raked over continually by coolies. This gives concentrates containing 98½ per cent of cassiterite. The impurities which are removed are chiefly ilmenite, with some monazite.

Another of the company's dredges (No. 4) is shown in Fig. 10.

The company operates its dredges by electric power from a central power station in the vicinity, where it is generated by burning coal which is mined in this same district.

At the present rate of working, the low lake and swamp area on which the company is now operating will be worked out in about thirteen years; but the company has other and larger areas to which its operations will then be transferred.

All the tin ore mined in Malaya, as well as about half the output of the Dutch East Indies, and some tin concentrates from Siam, South Africa, and Australia, is smelted either at Penang or at Singapore. There are two large companies engaged in tin smelting—the Straits Trading Company and the Eastern Smelting Company. The former is the largest tin-smelting company in the world and has works of large capacity both at Singapore and at Penang. The works of the Eastern Smelting Company are at Penang.

Oleic Acid in the Flotation of Oxidized Ores

OLEIC ACID was one of the first reagents employed for the flotation of sulphide ores, says Robert Lord, in a bulletin of the Southwestern Engineering Corporation. With the development of other oils and reagents its use has diminished until now it is rarely employed with sulphide ores.

Interest has been taken in it from time to time because of its properties in floating certain carbonates without previous sulphidizing. Recently, interest has been renewed by reports from the U. S. Bureau of Mines that oleic acid and sodium oleate have been used with a considerable degree of success in tests for the beneficiation of phosphate ores by flotation.

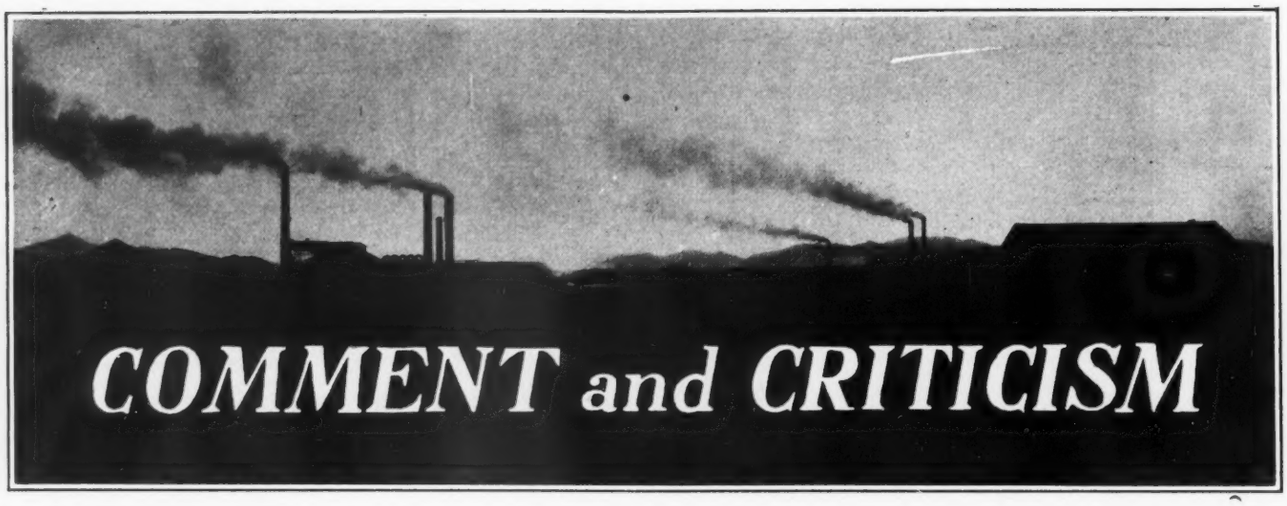
One of the most striking examples of the properties of oleic acid to float a mineral without previous sulphidizing is in the flotation of barite, natural barium sulphate. Often this mineral is associated with silica and oxides of iron. Oleic acid alone causes its flotation, but the concentrate is contaminated with considerable silica and oxides of iron. By employing sodium silicate in conjunction with oleic acid the concentrate is whiter and purer. The froth is also more brittle and breaks down readily. Control of the sodium silicate is necessary, as an excess prevents the froth from overflowing unless an excess of oleic is used. The correct amount varies with different ores. When correct amounts are employed, flotation of barite is easily effected and is quite complete.

Flotation of some of the heavy garnet gangue minerals may be quite readily effected with oleic acid and sodium silicate under the same conditions as for barite. Some success has been had in floating the tungsten mineral, scheelite, by using oleic acid and sodium silicate. Fair concentrates and recoveries have been obtained.

Many efforts have been made to apply these reagents to the flotation of oxidized lead ores. Tests have nearly always been successful in producing concentrate of fair grade, but there is a tendency to produce a high tailing, especially if oxides of lead are present. Carbonates of lead appear to float quite readily. Recovery of silica is usually lower than that obtained with a sulphidizing treatment. Calcium carbonate interferes because oleic acid tends to float it along with the minerals desired.

It has been observed in the separations mentioned, that an excess of silicate tends to retard flotation of the slime. Too small an amount does not appear to give the selectivity obtained when the correct amount is used.

Oleic acid, sodium oleate, stearic and palmitic acid possess the same properties of tending to float certain carbonates and entrain heavy minerals, but they have been applied only on a laboratory scale.



COMMENT and CRITICISM

Many Favorable Areas for Prospecting Still Exist in Canada

Alternative Opinion Suggests That C. M. Campbell Underestimated Possibilities in "Pre-Cambrian Misconceptions"

To the Editor of "E. & M. J.":

It was with considerable interest and pleasure that we read Mr. C. M. Campbell's article, "Pre-Cambrian Misconceptions," in the Aug. 4, 1928, issue of the *Engineering and Mining Journal.* Mr. Campbell is to be congratulated for the frank and fearless manner in which he expressed his opinions. The writers regret, with Mr. Campbell, that too much capital has been made from genial Dr. Corless' phrase "inconceivable wealth in mineral" in Canada. Unknowingly and unwittingly Dr. Corless has aided many an unscrupulous mine promoter to reap a harvest in the promotion of mining companies. Although we are in accord with many of Mr. Campbell's statements, we find a number of fallacies in his arguments, and feel that he has understated the possibilities.

First we disagree with him as to the restricted size of the favorable areas of Huronian rocks. (We take it that by "Huronian" Mr. Campbell includes all the Pre-Cambrian sediments as well as the lava flows.) For our purpose, however, we shall use the more recent terminology adopted by the Dominion and Ontario geologists, such as "Temiskaming," "Cobalt," and "Keweenawan," in referring to the divisions of the Huronian. We agree with Mr. Campbell that any success in prospecting presupposes that one confine one's efforts to areas of Huronian and Keewatin rocks. This fact has been well known by Canadian geologists in the last decade. Compared to the huge Pre-Cambrian area exposed in Canada, the exposures of Huronian and Keewatin are small. Actually, in linear extent, they are exceedingly large, and offer room for mining expansion in Canada for several more generations. Let us briefly consider the following regions:

1. The area of Keweenawan rocks along the Kaniapiskan River in the interior of Labrador. This comprises approximately 10,000 square miles which have never been prospected or traveled by a white man, owing to the present inaccessibility of the area.

2. The area of Keewatin rocks north of the Transcontinental railroad in Quebec, comprising 5,000 square miles. Though this section is traversed by several large rivers, making it fairly accessible, it is so heavily overburdened and forested that it must be regarded as virgin territory.

3. The area of Keweenawan rocks in Saskatchewan, 20,000 square miles, first prospected this year.

4. The area of Keweenawan at Chesterfield Inlet which aggregates 15,000 square miles. This area had never been prospected prior to 1928, and is now being explored by the Lindsley and Hammell interests.

5. The Rankin Inlet area of Keewatin, of 4,000 square miles, received its first attention this year.

6. The vast Coppermine area of Keweenawan, consisting of 100,000 square miles and known to contain native copper. This area is difficult to travel over, and for practical mining purposes is unknown.

7. The area of Kississing schists in Saskatchewan, the western extension of the Cold Lake (Sherritt Gordon) area. Here a large sulphide deposit was found early in 1928.

8. The area of schists and Keewatin extending from the Flin Flon to Split Lake, in Manitoba, which comprises approximately 15,000 square miles. Although prospectors have traveled a good part of this area, it has been prospected only superficially and is potentially an area of much promise.

9. Oxford Lake, God's Lake, Knee Lake, and Sandy Lake, Keewatin areas in Manitoba and Ontario, which aggregate thousands of square miles.

We believe the foregoing areas offer sufficient favorable prospecting ground to keep hosts of engineers, geologists, and prospectors busily engaged for many years. All that is necessary for the making of a large mining camp is an area of comparatively few square miles, as for example, the copper deposits of northern Michigan, the copper-nickel bonanzas of Sudbury, and the gold of Kirkland Lake, this last hardly covering more than one square mile! It must be remembered that we have not included any of the various small patches of Keewatin in Ontario and Manitoba.

Second, we disagree most strongly with Mr. Campbell that the various mines were found by canoe prospecting and that an examination of the shore lines of lakes more or less along the main canoe routes is sufficient to demonstrate the mineral possibilities of a whole region. Let us consider the original discoveries of some of our important Canadian mining camps.

1. The Kirkland Lake area. The original discovery on the Tough-Oakes was made about 1½ miles from the shore of Kirkland Lake. Incidentally, the main producing vein of the Lake Shore was beneath the lake, and the Wright-Hargreaves vein several hundred feet from the shore.

2. The Porcupine area. The Bannerman, the real original discovery, made early in 1909, was two miles from Porcupine Lake. The Dome discovery made by Preston was in the middle of a swamp several miles from the nearest waterway. We may say also that the Hollinger veins outcropped on a portage between the Mattagami River and Pearl Lake, one which had been used by several generations of trappers. According to Mr. Cleary Dixon, one of the stakers of the Hollinger, boot marks were visible on these gold-bearing veins.

3. The Rouyn area. The main showing of the Noranda was found 2,000 ft. south of the barren pyrite mineralization along Miller Creek which led Horne to

stake this ground. The Waite, Aldermac, and Malartic mines were found one-half, one, and three miles respectively from the nearest waterways.

4. The Flin Flon area. Though the original discovery was made on the shores of a small lake, this lake was far away from the main canoe routes, and information regarding the presence of mineral was given by an Indian trapper. The original Sherritt-Gordon discovery was made several hundred feet from the shore of Sherlett Lake.

The foregoing examples indicate that mines are not found along shores of a lake or stream merely by paddling about in a canoe, as Mr. Campbell would like us to infer by his article.

Third, we disagree with Mr. Campbell's statement "It is doubtful if there exists anywhere, outside of arid districts where the hills are bare, any area that is so thoroughly scratched as the great mass of the Canadian Pre-Cambrian." To anyone who has traveled the Canadian "bush" such a declaration seems far-fetched. We recall Rouyn, an area heavily overburdened and forested, in the fall of 1921 before the Horne orebodies were found. How little we imagined at that time a new camp would be discovered here! The uncovering of a little moss on the top of a ridge led to the development of the Horne Mine (Noranda).

After seven years of field work in Canada, the writers feel how futile it is for one to go into the "bush" anywhere in northern Canada and make predictions concerning the possible existence of mineral. An upturned root, removal of moss, a rock slide, a forest fire, low water—any number of conditions—may result in the finding of economic mineralization, and make the difference between virgin "bush" and a new mining camp.

To the prospector, mining engineer, and mine operator Canada offers an unparalleled field. The individual can operate under the same conditions as a large corporation. Concessions to companies are not granted by the government. Only faith, application, and optimism are necessary. An abundance of capital is available for new developments. In the field, and not in the armchair, are mining camps unearthed.

ROBERT D. HOFFMAN,
ARNOLD HOFFMAN,
KENNETH CARMICHAEL.

New York City,
Nov. 21, 1928.

Reminiscent of the Romantic Past

To the Editor of "E. & M. J.":

In the early days of the West, the Mission bells filled the peaceful valleys with melody. Then gold was discovered, and the *padres* and the melodies disappeared. The valleys swarmed with miners washing the golden sands, and multitudes of prospectors wandered through the mountains digging for rich quartz.

The first gold discovery was in California; the next in Gilpin County, Colo. According to U. S. Geological Survey reports, the counties of Gilpin and Clear Creek pioneered the gold-mining industry. No stamp mills were available in those days, but the accompanying illustration depicts the primitive gold mill of that period—the Spanish *arrastre*. The ore was crushed by dragging the heavy stone around the trough, by the rotation of the cross arm to which a burro was hitched. Quicksilver was used to recover the gold. The *arrastre* shown is in the city park adjoining the public school at Idaho Springs, Colo. I suppose that the city authorities erected the monument.

R. K. GRATIGNY.

New York, N. Y.

The first gold mill of the West—a primitive Spanish "arrastre"

The Tin Deposits of the Carolinas

To the Editor of "E. & M. J.":

The world consumption of tin for the first six months of the year ended June, 1928, totaled 75,110 long tons, and the United States consumed 40,099 tons, being more than half of the world's production. When we consider the amount of tin that is consumed each year and investigate the source of supply of this important metal, we begin to realize that the question as to where the world's supply of tin is to be obtained is important. The demand for tin is increasing rapidly, owing largely to the rapid growth of the canning industry. Our domestic production of tin has been insignificant, when compared with our consumption, and like most of the larger consuming countries of the world, our production of tin remains close to zero. On account of the value of tin it is possible to work very low grades of ore if they are in quantity. Usually there is but little difficulty in cleaning and concentrating tin ore so as to obtain almost a pure product.

Considering the existing conditions in the tin industry, the occurrences in the Carolinas are looming up as possible sources of a considerable domestic supply of tin.

Tin was discovered in the vicinity of Kings Mountain, N. C., in 1883, and systematic prospecting started in a slow way in 1886. In 1888 a small test stamp mill was erected and two carloads of concentrates were shipped to England. One load contained 2½ per cent metallic tin and the other 1½ per cent tin. Litigation, the nemesis of tin production in this country, forced the operators to close. The Ross Mine, in South Carolina, was discovered in 1903.

GEOGRAPHICAL LOCATION

The Carolina tin belt extends from Gafney, Cherokee County, S. C., in a general northeasterly direction across this county, and through the southeastern corner of Cleveland County, N. C., and across Gaston and Lincoln counties. The tin deposits on Irish Creek, in Rockbridge County, Va., are in all probability a continuation of the Carolina belt, as the general direction of the rocks carrying the tin is the same and a continuation of the direction from the Carolina deposits would cross the Irish Creek deposits.

The principal tin locality in South Carolina is about a mile north of Gafney. Tin is known to occur, also, a short distance from Grover, N. C., a station on the Southern Railway, and from this point tin has been found almost continuously for a distance of 14 miles to within a few miles of Lincolnton, Lincoln County, N. C. The Southern Railroad passes over a considerable part of the tin belt, following its general direction from Kings Mountain to Gafney. Any commercial deposits that may be developed along this belt will have good railroad facilities, as their greatest distance from the railroad will not be over two miles.

The tin belt occurs in a section of North Carolina and South Carolina near the border of the large area of Archean gneisses which extend over a large part of the western part of North Carolina and the northwestern part of South Carolina. A series of granites and other igneous rocks border the gneisses on the east and extend from Cherokee County, S. C., across Mecklenburg, Carbarrus, Rowan, Davidson, Guilford, Caswell and Person counties, N. C., having a general north to northeast direction.

GEOLOGY

In the southern portion of the belt in North Carolina, extending into South Carolina, a band of metamorphic slates, schists, limestones, quartzites, and conglomerates separates the granites and gneisses. This formation is prominent in Cherokee County, S. C., and in Gaston, Lincoln and Catawba counties, N. C., and outcrops again in the northeastern portion of Yadkin County. In Gaston and Lincoln counties this formation is penetrated by a mass of granite which is from 5 to 10 miles wide. The general strike of the metamorphic rock is northeast, and in this belt of rocks the tin is found. The strike of the tin veins is practically the same as the metamorphic rocks in North Carolina; near the South Carolina line the tin formation bends to the west and passes through the Archean gneisses. Tin veins have been found in rocks of two different geological ages: (1) Those associated with the Archean gneisses which are found in the vicinity of Gafney, S. C.; and (2) those associated with the schists of a later age, in which most of the North Carolina tin is found. The width of the metamorphic belt in the vicinity of Kings Mountain is about 10 miles.

These metamorphic formations are tilted at a high angle and they form the tops of the peaks and ridges such as Kings, Crowders, and Anderson mountains, being from 500 to 1,000 ft. above the average elevation. Evidently the mass of granite to the east has thrown them in their present position. The metamorphic rocks are cut by a number of amphibolite dikes. Pegmatite dikes are common in the metamorphic rocks; in some instances they can be traced for 5 miles and are 200 ft. wide.

The tin occurs in greisen veins, and where the tin occurs in the pegmatitic it is in greisen veins near the boundaries where the fumarole action is the greatest.

DEVELOPMENT WORK

Some development work has been done at the Ross mine, about a mile east of Gafney, S. C., proving a tin-bearing area 1,000 by 600 ft., varying in depth from 8 to 10 ft., and in a portion of the decomposed tin formation suitable for a placer operation. The richness ranges from 12 lb. to 75 lb. per cubic yard, and the average should be about 25 lb. per cubic yard. About 4 miles southeast of Kings Mountain some exploratory work has been done, proving the existence of a tin-bearing formation for the distance of half a mile.

In 1888, exploration work was done on the Ledoux property, about 2 miles southeast of Kings Mountain, and without any attempt to sort the rock from the various excavations covering a considerable area the rock yielded around 0.5 per cent tin. Diamond drilling at this point proved the mineralization to extend to a considerable depth. In the vicinity of Chestnut Ridge the small amount of exploration work gives promise of favorable results. One of the most promising deposits of tin is 3½ miles northeast of Bessemer. A number of veins have been observed on the surface from two to three feet wide, and they carry around 5 per cent tin.

ECONOMIC VALUE OF THE DEPOSITS

With tin selling around 50c. per pound there is no question in my mind as to the value of the alluvial deposits and the vein material. If the alluvial deposits carried only 12 lb. of tin per cubic yard, the value would be close to $6 per yard, and the value of ore from a 1 per cent vein would be close to $10 per ton.

As I view the matter, the Carolina tin deposits are a promising field for capitalists of limited means, and in most instances a few thousand dollars spent under the proper technical skill would prove the merits or demerits of the deposit at the point under exploration.

MARSHALL HANEY.

Geer, Va.

Prospecting for Diamonds and Asbestos in South Africa

To the Editor of "E. & M. J.":

Realizing that many thousand square miles of country must be searched, and that there were 8,000,000 natives and only 1,000,000 whites, of whom few were qualified and available to prospect for minerals, a plan to weld the native Zulu, Metabale, Swazi and others into a gigantic prospecting force was adopted in South Africa. The natives were instructed, by signs, to search the craws of the chickens and game birds, when killed, for diamonds, and report to the nearest store upon finding diamonds which had been picked up by the hens while feeding.

Diamonds occur for the most part in extinct volcanoes—volcanic heat and pressure form them. All over South Africa there are billions of ants which make earth mounds in the form of cones over their hives 2 to 4 ft. high. Diamondiferous soil weathered and oxidized by millions of years has a distinctive yellow color. Fowls having indicated diamonds to be in a district, ants showed the prospector exact location of the diamond mine by the color of the ant hill. In this manner the richest mine of all, the Premier Diamond mine, in the Transvaal, 3,000 claims in extent, was found. There are five diamond mines in Kimberley, the largest having a surface area of 71 claims (a claim is 20 sq.ft.).

For the discovery of asbestos in the Carolina districts of the Transvaal and the Rhodesian deposits, the native chiefs were again utilized. The asbestos fiber of the Canadian deposit was secured and distributed among the natives and they were requested to report where a similar substance could be found.

J. B. CARPER.

Louisville, Ky.

The Borderland Between Ore and Waste

To the Editor of "E.&M.J."

Your editorial in the Nov. 24 issue of *E.&M.J.* entitled "The Borderland Between Ore and Waste" brings up a subject of considerable interest to the profession. Every engineer has frequently felt the need for a short term meaning mineralized rock that is, strictly speaking, neither ore nor waste.

You suggest the name "subore" for such material, the prefix "sub" meaning under or below. This seems to me hardly suitable, as "subore" might be construed to mean ore that comes from a lower horizon than some other ore (in a mine). Subore, subsoil. "Sub" as commonly applied as a prefix suggests relative position rather than relative value.

The term "near-ore," which you refer to humorously, is worthy of more serious consideration, but for fear of being pronounced guilty of stealing from the language of the beverage maker I suggest the term "proxore" as meaning the same thing and being a little more "high sounding."

F. M. WICHMAN.

Salt Lake City, Utah

Vacations on Pay

To the Editor of "E. & M. J.":

The mining company of which I have been an official for five years made a rule that any employee who worked for six months could take a week's vacation on pay. We considered that a mine employee has the same right to a vacation as a city employee. We imagined that this would lessen labor turnover and that the men would take more interest in their work.

On both these points we were mistaken. After a five years' trial we abandoned the practice because it was not appreciated by the men and did us no good. The end came when a miner who had been given eight days' vacation on pay made bitter remarks on his return because on Thanksgiving Day we did not give a whole day off on pay. We did give the afternoon off, however.

A discussion on this subject would be of interest, and I would be glad to learn of the experiences of others in this respect.

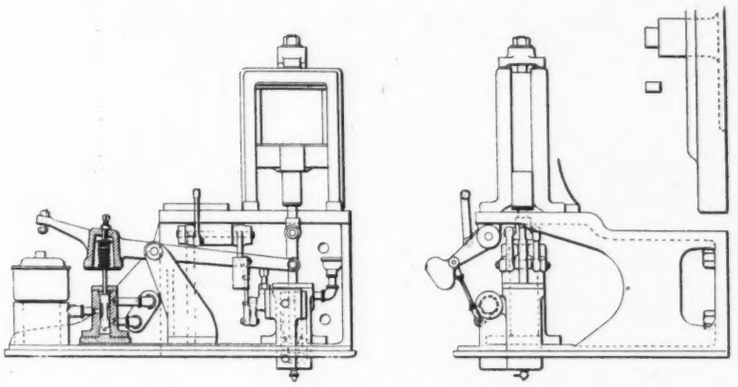
SUPERINTENDENT.

San Francisco, Calif.

INDUSTRIAL PROGRESS

Improved Control of Hoist Braking Possible With New Devices

SOME new developments in the hoist brake field have been effected by the Ottumwa Iron Works, Ottumwa, Iowa. They are, respectively, an emergency trip device and the provision of a means of deferring the emergency application of the brakes under certain conditions.



Emergency trip device for hoist brakes

These devices are being used by the company in connection with its "proportional braking system" which it developed several years ago to make it possible for the hoist man to know when his brake starts to apply and to what extent it is being applied.

The Emergency Trip Device

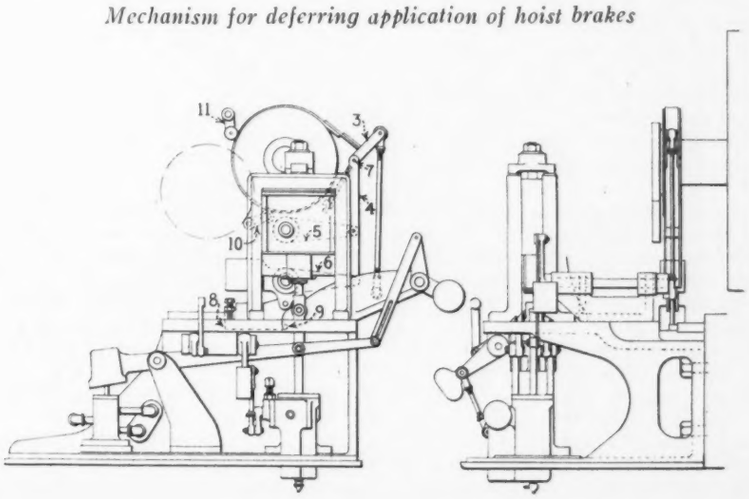
The emergency trip mechanism applies the brake in precisely the manner the operator should. On interruption of power the brake immediately settles to the drum and increases its braking effect at a predetermined rate. The above cut shows this emergency device.

A solenoid is placed above an oil dash pot and operates through a lever to apply pressure on a valve stem by means of a compression spring similar to the one that is over the operator's valve. Each position of this lever corresponds to a different tension in the spring and a different pressure on the valve stem, and requires a different pressure in the thrust cylinder to maintain the valve in neutral position. The result is that each position of this lever corresponds to a definite amount of braking. The dash pot is so arranged that the solenoid has a certain amount of free drop before it is cushioned by the dash pot. At the end of the free drop, the pressure called for in the thrust cylinder is slightly less than sufficient to maintain the brake weight, with the result that when the solenoid is tripped the brake weight descends immediately to the drum and gives a slight amount of braking. The operation of descent of the solenoid core and dash pot is controlled by a valve connected to the cam overwind and operated in such a manner that for mid positions of the cage or skip the descent is very slow. Near the end of the travel of the skip or cage the descent is very rapid, until at the end of the travel the dropping of the solenoid is free and complete. This accomplishes an application of the brake just as the operator should manipulate it if he were to stop the hoist in emergency. The slowing down and stopping of the hoist in mid positions of the cage is so delicate that men on the cage are unable to detect whether the cage is stopped by emergency or stopped by the operator. Near the end of travel the brake goes on immediately the full amount allowed the emergency application.

On top of the dash pot will be noted a setscrew which forms a stop for the brake-applying level. By adjusting this setscrew the maximum amount of braking in emergency application may be delicately adjusted, regardless of the adjustment of the brake shoes. In many cases this is an important feature. The maximum power of the brake in the case of slope hoists may be greater than the ordinary hitchings will stand. In such a case, the maximum amount of braking allowed the emergency device is limited so as not to endanger hitchings. This is accomplished by reading the ammeter when pulling out a load and adjusting this setscrew so that the motor can turn the drum through the brake at the same ammeter reading when the brake is tripped in emergency and the lever resting on the setscrew.

To reduce the size of this trip mechanism to a point commensurate with other parts of the hoist, and to avoid lengthening the line of communication between the operator and his thrust cylinder, the oil valve of the trip mechanism does not operate directly in the line of communication between the operator's valve and thrust cylinder. It operates a relay valve. This valve is three ported. The upper port is in communication with the second port of the operator's valve; the middle port is in communication with the thrust cylinder; and the lower port with the sump tank. The valve is entirely inclosed and runs in oil. That space which is on the bottom of the valve is in communication with the middle port of the pilot valve on the trip mechanism. The space above the valve is in communica-

Mechanism for deferring application of hoist brakes



tion with the thrust cylinder. Since this valve is usually lower than the trip mechanism, the weight of the valve itself tends to balance the head of oil between the trip mechanism and this relay valve. Operation of this valve is to maintain in the thrust cylinder exactly the pressure called for by the pilot valve in the same manner as the operation of the operator's valve.

THE DEFERRED BRAKE APPLICATION

There are many slope operations in which it is dangerous to have an emergency application of the brake lest it apply on failure of power during an up-going trip and absorb the energy in the rotating parts of the hoist, preventing the drum winding up slack rope, in which case the trip overrides the rope and when backing down brings the rope taut with such a jerk as to break hitchings and precipitate the trip of cars to the bottom of the slope. To afford protection against overspeeding and overwinding in such cases, some provision must be made to prevent the brake from applying so long as the drum will wind up more rope. Fig. 2 shows this mechanism for deferred brake application. Its object is to prevent brake application even after power has been cut off so long as the drum will wind up more rope, but to allow brake application as soon as the drum starts to turn in the opposite direction. The brake being off when the trip settles its weight on the rope allows a slight cushioning and prevents the rope becoming taut with a snap. No part of the mechanism moves or wears during the ordinary manipulation of the hoist. The mechanism is put into operation by the initial movement of the emergency trip and acts instantly to accomplish its purpose. It then returns automatically to its initial position, where it remains without motion or friction of any kind utill it is again called into operation.

The deferred brake application mechanism consists of an extension on the drum shaft or a small brake ring on the extension of the drum shaft, and a small band brake surrounding this ring or extended shaft. It is well known that a single band brake pulls on the anchor end about three times as hard as on the movable end. This little brake is connected by a lever, No. 3, through a bell crank and slotted rod to the emergency trip lever of the emergency trip device. Lever No. 3 is so proportioned that the pull on the connection at the top of the small band brake is much greater than one-third of the pull on the bottom connection, with the result that as the drum is turning anti-clockwise, as shown in the figure, the small band brake becomes a positive locking device revolving as a unit with the shaft and through the bell crank holding the lever of the trip device in the upper position.

In order that this revolving motion shall have a limit at the proper time, a parallel motion consisting of levers No. 4, 5, and 6 is introduced, whereby the point No. 7, where lever No. 4 connects to lever No. 3 and the lower half of the small brake, revolves exactly as though it were connected by a rigid lever to the center of the drum shaft. Lever No. 6 is counterweighted to slightly overbalance this parallel motion and the weight of the small brake. Attached to lever No. 6 is a second weight, No. 8, which aids the counterweight of No. 6 in bringing the mechanism to its initial position. Weight No. 8 rests on a fixed pin, No. 9. In this initial position the small brake is entirely free from the drum, being supported by small rollers, No. 10 and 11. The initial motion of the emergency trip lever pulls down on lever No. 3, tightening the small brake, and, as the drum is turned anti-clockwise, the lower end of the brake is sucked in and the small brake becomes positively locked. The amount that it can pull up the emergency lever is regulated by setscrews in weight No. 8, as this weight must approach the counterweight on No. 6 as the lower end of the small brake is pulled upward. This limits the revolutions of the small brake with its connection to the emergency lever by reducing the excessive pull on the lower end of the brake.

As the drum starts to turn in the opposite direction, the mechanism allows the emergency lever to settle to its predetermined position and allows the application of the brake. As soon as the emergency solenoid is re-energized, the emergency trip lever rises and the mechanism is free to resume its original position, which re-establishes clearance between the small brake and the drum. There are no parts which wear or move during the ordinary operation of the hoist.

Protecting a Jaw Crusher Against Breakage

A NEW and effective device for protecting jaw crushers against breakage is illustrated in the accompanying cut. It has been patented by the Traylor Engineering & Manufacturing Company, Allentown, Pa., and has been announced by that company as one of the features of its Bulldog jaw crusher. The device protects all parts of the machine from injury in the event that the pitman rods are subjected to a dangerous overload by reason of tramp iron being introduced with the feed or the choking of the discharge opening with damp or sticky material. It consists primarily of a punch, actuated by the eccentric shaft of the crusher, and a punching bar, through which the punch is driven when excessive strains are developed.

Details of the device are as follows:

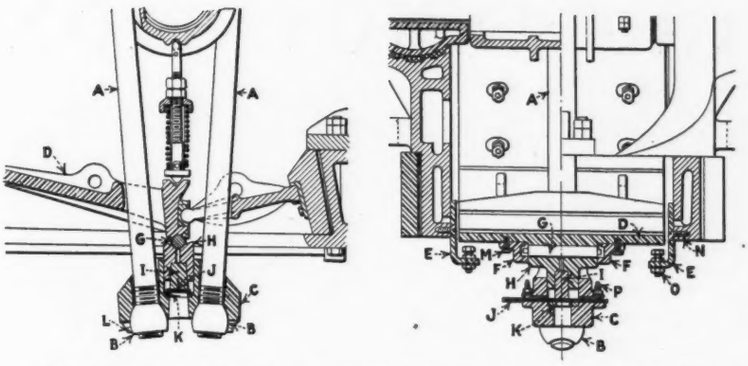
Two cast-steel plunger roller brackets *F* are bolted to the underside of the back end of the front toggle *D*, which brackets hold a forged steel plunger roller *G* in position. The cast steel pitman rocker *C* is bored to receive a cast steel plunger *H* which acts to apply pressure to the knee of the front toggle, through the plunger roller secured thereto as described. The plunger is designed with a taper-bored recess on the under side, into which is tightly driven a heavy tool-steel punch, *I*.

At the bottom of the machined recess in the top of the pitman rocker is fixed a heavy tool-steel die, *K*, having an opening which corresponds to the size of the punch *I*, under which die is a hole slightly larger in diameter than the opening in the die, cored through the bottom of the rocker casting to provide escape of punchings. The punch, being fixed in the plunger, is aligned with the die, as a result of the sliding fit of the plunger in the bore of the rocker.

The pitman rocker is further designed with a rectangular opening on each side to receive a punching bar *J*, of mild steel, which rests upon the die and is normally locked in position by two setscrews *P*, one on each side of the rocker. The punch rests upon the punching bar, and the plunger which carries the punch engages the plunger roll, superimposed upon which is the front toggle *D*, which supports the rear toggle, all parts thereof being held in contact by the spring jack and the tension rods. Thus, since the pitman rocker *C* is supported from the pitman cap by the two pitman rods *A*, *B*, *L*, most of the weight of the two toggles and all of the weight of the plunger roller, plunger, and punch rest upon the punching bar while the crusher is operating.

The safety device functions when dangerous strains are developed through packing or other obstructions in the discharge opening of the crusher. When the yielding point is reached (predetermined by the thickness of the punching bar), the punch is driven through the punching bar by a heavy downward pressure, excited by the front toggle, through the plunger roller and upon the plunger, which carries the punch. Thereupon the slug that is punched out falls out of the pitman rocker and the toggles drop, the back end of the front toggle falling until it is stopped by and rests upon the two adjusting bolts of the two toggle supports, one of which is bolted to each side of the crusher frame.

The stops serve to prevent the toggles from dropping below a limited distance, so that the motion of the actuating device is less than the clearance of the mechanism after the safety device has functioned. Crushing immediately ceases, because the clearance between the plunger and the plunger roller is greater than the total vertical stroke of the pitman. The pitman continues to work, but instead of lifting the toggles to move the swing jaw forward, it simply works up and down on the plunger,



Details of safety device for protecting jaw crusher against breakage

the punch passing through the hole perforated in the punching bar.

To resume crushing it is necessary to stop the machine, remove the obstruction which caused the safety device to function, and by means of a jack lift the toggles into closed position, the pitman being at its lowest point. A bar is then inserted underneath the punch, and punch and plunger are lifted and held in highest position. The setscrews holding the punching bar are then released and the bar is moved in either direction to present a new surface for the punch. Then the bar is secured in place by the setscrews and the jack holding the toggle is released to allow the punch to rest upon the bar, thereby supporting the plunger and the toggles. The machine is then ready to operate again.

This safety device is thus simple and positive in its action, as well as being highly economical, since the parts are subject to but little wear, except the punching bar, which may be replaced at negligible cost. Moreover, little time is lost in making adjustment, for if the necessary jack and wrenches are kept handy the punching bar may be moved over to a new position in about five minutes.

Other features of the crusher are: A pitman of the rod type, which is lighter and stronger than the bulky solid pitman of the old Blake design; a three-bearing toggle system, designed for rolling instead of rubbing, with consequent lessened friction; self-aligning pitman-shaft bearings; saving of power and lower maintenance cost, owing to reduction of weight and lessened friction; accessibility of parts; and, finally, general sturdiness of design.

Training of Welders Important

ONE of the most significant developments in the last year or two in the welding field is the attention that is being given in this country to procedure specifications in important welding operations. One of the prime requisites of proper procedure specifications is having qualified operators for the work to which they are assigned.

It is not sufficient to take welders who have had five years' or more experience and conclude that they are expert for the work in hand. It is now recognized that a welder who may do excellent work on thin material will not necessarily be able to make good welds on thicker material without additional training. The position of welding is also of importance. For example, a man may do 100 per cent work on plate welding in a "flat position," but will make poor welds on pipe-line work where some overhead welding may be required.

There is a tendency to classify welders and give them work for which they are particularly fitted. For example, in pipe-line welding a welder may be able to do 100 per cent work in making joints with the pipe turned around to provide an easy position for welding, but he may utterly fail to make a good "bell-hole" weld.

It is, therefore, essential that a welder be tested for the work which he is to do, the report of the oxy-acetylene committee of the International Acetylene Association declares. These test specimens should be made up of material of the same thickness and with the same preparation which the welder will encounter in service. If vertical welding will be required of him, some specimens should also be made in this position. The American Welding Society has given considerable attention to this important matter and a report of this subject was published in the May, 1928, issue of the journal of the society.

The importance and necessity of qualifying welders by a suitable check test cannot be overemphasized. It has often been said that a chain is no stronger than its weakest link. A well-set-up organization will see to it that proper materials and apparatus will be supplied. It can also be reasonably expected that the designing department will work out designs particularly adapted to welding both from the standpoint of economy and dependability of the welds if properly made. It is, therefore, only reasonable to expect that the same care will be taken to qualify the welders for the work which they are expected to do. The designing department will then have accurate knowledge of what may be expected for a particular joint in service, because they will know that the welders employed are capable of repeatedly producing a product of uniform known strength. It then remains for the regulatory or supervising force to see to it that such welds are produced.

As to the exact mechanism for training of welders, this has been worked out with a great deal of care by a number of the important manufacturing companies, trade schools and by the American Welding Society, working in co-operation with the Federal Board for Vocational Education.

When complete control is obtained through proper procedure specifications, welding will advance rapidly and will have the confidence of conservative engineers and regulatory bodies.

INDUSTRIAL NOTES

The Miami Copper Company has ordered the following switching apparatus from the Westinghouse Electric & Manufacturing Company: The order calls for thirteen electrically operated, Type "B-32" oil circuit breakers, together with supporting frame, disconnecting switches, copper bus and connections, bus bar supports, instrument transformers, and bolted steel structures. This apparatus controls thirteen circuits, seven of which are 600 amp., four 800 amp., and two 1,600 amp. The frame and equipment are being completely assembled at the manufacturers' works and will then be disassembled and shipped to the Miami plant. All parts are completely fitted, as the structure is to be erected within 6 in. of the present structure which it will supersede. When the new equipment has been entirely installed, the old structure will be dismantled and removed with practically no interruption of service.

The Mine Safety Appliances Company, Pittsburgh, Pa., has opened a Pacific Coast branch, including offices and warehouse, at 318 East Third St., Los Angeles. The new branch is in charge of H. E. Munn, who received his early safety training with the U. S. Bureau of Mines and later was associated with the Jackling mining interests. Mr. Munn is assisted by C. E. Gault, also formerly associated with the Bureau. In addition to the Pacific Coast branch, the Western organization of the company also includes the following district representatives: J. C. Calnon, El Paso, Tex.; T. R. Jones, Denver, Colo.; V. O. Murray, Salt Lake City, Utah, and H. H. Sanderson, Seattle, Wash.

J. L. Tildsley, Jr., formerly with the American Cyanamid Company, is now identified with the tar products division of the International Combustion Tar and Chemical Corporation, 200 Madison Avenue, New York, N. Y.

The New York office of the Brown Instrument Company has been moved to Room 1502, 117 Liberty St., from 50 Church St.

COST-CUTTING INNOVATIONS

ELECTRICAL — MECHANICAL — MAINTENANCE

Larger Units Insure Reduced Operating Expense

THE Miami Copper Company is about to install two of the largest Dorr bowl classifiers ever built, a shop view of one of which is shown herewith. These mammoth machines are 20 ft. wide and 42 ft. long, with 28-ft. diameter bowls, and are of the heaviest construction throughout in order that each may handle more than twice the tonnage ever before handled in a classifier.

The reciprocating rake mechanism is of the sextuplex type, consisting of six sets of rakes driven by cams and rods from a single extra-heavy head motion. The bowl compares in size with commercial sizes of concentrate thickeners. In mechanism the bowl also follows thickener practice, in that it is supported by a bridge-type superstructure and is provided with a lifting device.

These large classifiers will operate in closed circuit with ball mills in the secondary grinding circuit, overflowing a 48-mesh product to the flotation machines. They are designed to overflow 3,000 tons of flotation feed per day and are capable of handling a circulating sand load of 6,000 tons per day.

Following, as they do, the installation of Miami's 325-ft. thickener last summer, these classifiers may be regarded as another instance of the present trend toward large milling machinery.

Repairing the Outside Rim of Car Wheels

CAR or truck wheels can be repaired more cheaply when the flange and outside rim are worn down or have flat spots, if the work is done as suggested in the following: To rebuild the flange it is best to weld it all around the edge, filling up the low spots. The best way to repair the outside rim is to turn the wheel, except the flange, down in the lathe, taking off about one inch all around, and to shrink a steel band on the outside. After the wheels have been once turned down, new tires can be applied as the old ones wear out. The flange can be left on, as the wear is less than on the tire itself.

The tire can be made of flat steel and bored out $\frac{3}{32}$-in. smaller than the outside diameter of the turned-down wheel, which should be 2 in. smaller than the outside diameter of a new wheel. This will make the tire or band 1 in. thick all around and will give the repaired wheel the same size when finished as a new wheel. When the band is being made, enough stock should be left on it so that it can be finished to these sizes. These dimensions are for small car wheels only. Other sizes should be in proportion.

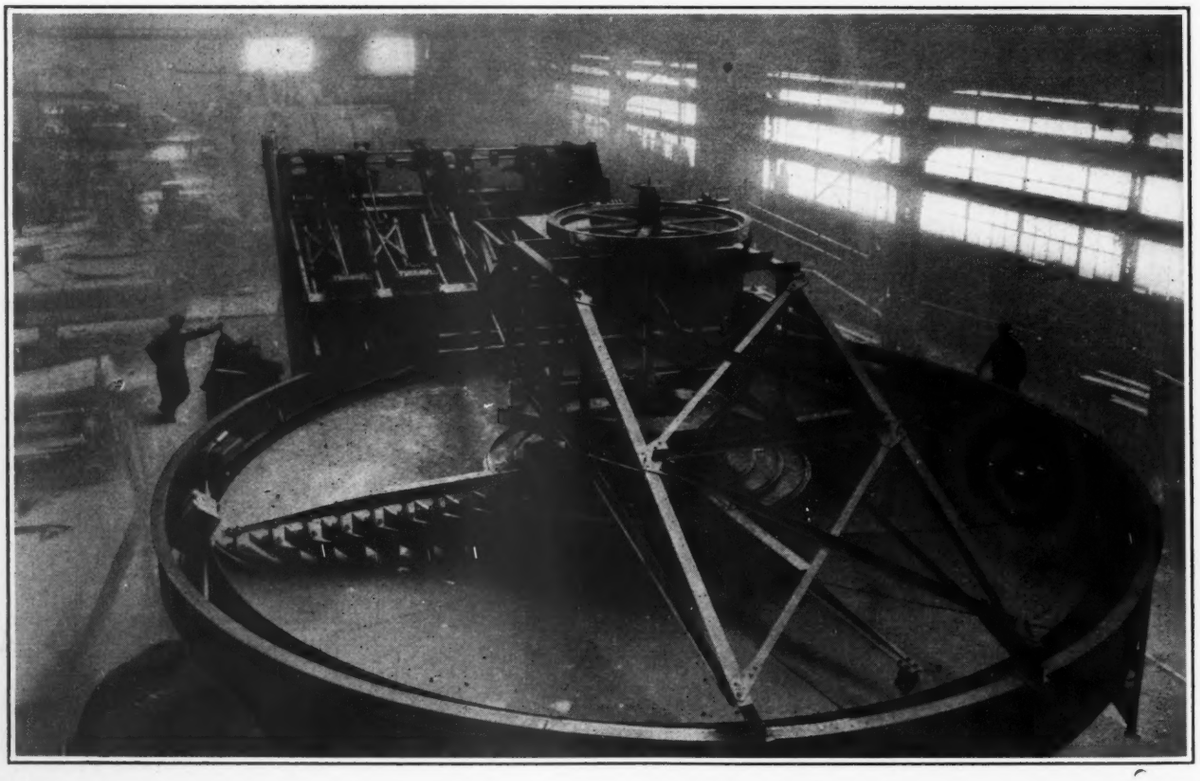
A good welder can lay the welding iron in the corner of the cut flange so that it will not be necessary to turn the flange in the lathe.

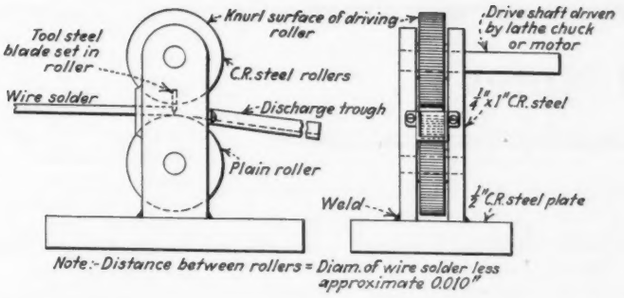
To shrink the tire on the wheel the best way is to use a pipe bent to the same size as the outside of the wheel and to drill $\frac{7}{8}$-in. holes around the inner side of the circle. After placing this pipe around the tire, oil can be used as a fuel, with air pressure to heat the tire. By placing the tire in the forge, the blacksmith can get it hot enough to shrink it on most small car wheels.

Hydrogen-Ion Control an Aid in Water-Softening

AKNOWLEDGE of the *pH* (hydrogen-ion concentration) of the water through the different stages of the softening process enables the most

Modern methods demand units of a size commensurate with tonnage handled. The trend is toward larger machines, as this illustration of an immense bowl classifier indicates.




Knurl surface of driving roller
Drive shaft driven by lathe chuck or motor
Tool steel blade set in roller
C.R. steel rollers
Wire solder
Discharge trough
1" x 1" C.R. steel
Plain roller
Weld
1" C.R. steel plate
Note:- Distance between rollers = Diam. of wire solder less approximate 0.010"

Solder-cutting machine

efficient results to be obtained in a plant where lime is used for softening, says *Industrial and Engineering Chemistry* for November, in abstracting a paper on the subject of "Hydrogen-Ion Control in Water Softening," by John R. Baylis.

The approximate saturation equilibria of calcium and magnesium carbonates have been established. The concentration of magnesium carbonate at saturation equilibrium is much higher than calcium carbonate for a given *pH*. Most natural waters contain some magnesium carbonate, and this throws the saturation equilibrium somewhat higher than that indicated by the curve for calcium carbonate.

Magnesium begins to precipitate as the hydroxide when the *pH* is increased above 10.3. Where the magnesium occurs largely as the carbonate, it can be reduced to about 3 p.p.m. of magnesium by increasing the *pH* to about 10.8 by the addition of calcium hydroxide.

The maximum softening possible for waters containing both calcium and magnesium carbonates is to add lime until the *pH* is about 10.8 and then precipitate the calcium by converting it to the carbonate.

It is better to recarbonate at two or three stages of the process than to attempt to recarbonate at only one point, according to Mr. Baylis.

Substation Change Cuts Cost $8 per Day

NOT often is it possible to obtain measured figures of power saving in kilowatt-hours or dollars resulting from moving a substation closer to the center of load in order to effect better voltage regulation. Usually other conditions affecting the power consumption change at the same time, making it difficult to prove just what credit should be given to the new arrangement of the plant, according to *Coal Age* in a recent issue.

One instance where conservative figures of actual saving became available was at No. 11 mine of the Old Ben Coal Corporation, Christopher, Ill. On Jan. 11, 1928, an automatic substation, installed on the surface about one mile from the main shaft, was put into service. Before this all 250-volt d.c. power was supplied from a substation near the main shaft. At the time the new substation was built the company changed the transmission to 2,300 volts to gain the obvious advantage.

Records of power consumption for the old substation were available from readings of a watt-hour meter permanently installed in the a.c. feed. The new substation was fed through the same meter.

The measured saving per day has averaged 500 kw.-hr., which amounts to $8. As the tonnage was increased somewhat coincident with the substation change, the actual saving by the new arrangement is probably even greater than this figure.

To supply the main haulage near the shaft it is necessary to continue to run the old substation. Were conditions such as to make possible shutting this down and eliminating the losses therein, the saving would undoubtedly be much greater.

Solder-cutting Machine Saves Time

IN THE wiring of switchboards and other equipment in which a large number of lug terminals are used, the work can be done more speedily and neatly, and an appreciable amount of solder can be saved, if wire solder be cut in lengths so as just to fill the cup of the lug when the conductor is inserted, according to Fred Harbel, of the Detroit Edison Company, in *Electrical World* for Nov. 3. To cut the solder to these determined lengths the company has in its shop a small machine along the general line of the sketch reproduced above. The device resembles a toy clothes wringer, except that the rolls are of metal; the lower one is smooth and the upper roll is knurled to prevent slipping and carries a tool-steel cutter that cuts off the solder as the two revolve. Supporting end frames, arranged to be set in a lathe bed; a driveshaft extending from the top roll which is chucked in the lathe or motor-driven; and a take-off trough complete the machine. The rolls are set up together, so that the wire solder is pulled into them as they revolve, and the cutter slices off lengths equal to the circumference of the upper roll. Different lengths of solder may be cut by using rolls of different diameters.

With the lathe turning at reasonably high speed, this machine will cut enough solder in a couple of hours to keep a crew of copper benders busy for several months.

New Electrical Solder Effects Significant Economies

SOLDERS used for electrical apparatus generally consist of alloys of lead and tin, the most common having equal parts. All lead-tin solders have the common feature that they start to melt at a temperature of 183 deg. C. (356 deg. F.). This means that a joint soldered with any of them will soften and fail if heated to this temperature.

A solder having a higher melting point is desirable for many types of electrical apparatus, where the service is severe and where, consequently, high temperatures are encountered, such as railway and mine motors, and circuit breakers. Attempts have naturally been made to replace the lead-tin solders with other alloys, but prior to the development to be described none has been successful on a practical scale. This was due to the fact that severe requirements must be met by a solder to be used in electrical apparatus.

A new solder, having a melting point of 304 deg. C. (580 deg. F.), recently developed by Dr. James Silberstein, of Chicago, has proved successful under conditions where trouble has been experienced with the old solders. The new solder consists of lead as a base, to which certain percentages of silver and copper have been added. The soldering operation is almost the same as when using the ordinary lead-tin solders, the only difference being that the soldering iron must be heated to a higher temperature. No special flux is required. The non-corrosive fluxes ordinarily used in the soldering of electrical apparatus are also used when soldering with the new solder. No special instruction of the laborer is necessary. The solder, which is being manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been put in service in various parts of the United States and Canada.

The new solder is to be recommended for electrical apparatus, where the common lead-tin solders are likely to fail on account of too high temperatures being encountered in service, and where brazing alloys, which have a melting point of above 700 deg. C. (1,300 deg. F.), cannot be used. The first place where the new solder was applied on a practical scale was in the motors of the electric locomotives of the Virginian Railroad, which are the largest and most powerful in the world.

Welding Pipe Cuts Costs

Probably no application of oxy-acetylene welding has taken any greater stride forward during 1928 than welding in the construction of industrial piping for high and low pressure steam, water, compressed air and the other industrial services. Executives and engineers alike have accepted welding for piping as the answer to the problem of leaky joints and have found not only that maintenance costs are reduced, but even that installation costs are lower with welded piping.

Personal Notes

F. W. CAMP has acquired the Indian Hill hydraulic mine, near Camptonville, Calif.

ROBERT GAMBLE, of Granada Rouyn Mines, has gone on a trip to the West Indies.

DUNCAN SMITH, mining engineer, has returned to Brussels, Belgium, from East Africa.

W. G. SWART, vice-president and general manager of Mesabi Iron, was recently in New York.

J. PARKE CHANNING, of New York, has been visiting the Miami Copper mine, at Miami, Ariz.

V. L. MATTSON, mining engineer with Norrie & Tower, has been in New York on professional business.

CHARLES HARDY is sailing for Europe from New York today on the "Majestic." He will remain there several weeks.

J. B. STITT, consulting engineer for Capital Rouyn Mines, is making an examination of the Sterling claims, Hess Township, Sudbury district, Ontario.

C. Q. SCHLERETH has arrived in New York from London on his way to Queensland, Australia, in connection with the operations of Mount Elliott, Ltd.

D. C. SHERMAN, of Sherman & Reilly, consulting engineers, of Chattanooga, Tenn., has been in Colorado, Utah, and California recently on professional business.

J. J. SHAW, manager of Sunnyside Mining & Milling, the U. S. Smelting Refining & Mining subsidiary at Eureka, Colo., has returned to Eureka from Salt Lake City.

R. B. GARFF, manager of Commonwealth Lead Mining, operating a property at Melrose, Mont., and shipping to Utah smelters, was in Salt Lake City recently.

ETIENNE A. RITTER, mining engineer and geologist, of Denver, Colo., has just returned to that city after some mine examinations in northern New Mexico.

ANTON GRONINGSTATER has accepted a position as metallurgist with Falconbridge Nickel Mines, which owns properties in the Sudbury district of northern Ontario.

W. B. PORCH is in charge of operations at the Cloverdale mine, in the Canon City district of Colorado, where a strike of high-grade copper-silver-gold ore was made on Dec. 11.

BENJAMIN B. THAYER, vice-president of Anaconda, has returned to New York from Montana, where he went on his semi-annual trip of inspection of the company's properties.

JOSEPH MCAULIFFE, vice-president of the Mace Company, Denver, Colo., is leaving on Jan. 4 for an extensive trip to South and Central America in the interest of the company.

MURL H. GIDEL, of the geological staff of Anaconda Copper Mining, recently addressed students of the Montana School of Mines, at Butte, on "The General Geology of Butte."

DR. J. J. RUTLEDGE, of Baltimore, has been appointed chairman of the ventilation subcommittee of the national committee on mechanized mining, which was recently created by the American Mining Congress.

C. L. HEWITT has resigned as engineer of the Montana-Idaho Mines Corporation, operating properties near Winston and Spring Hill, Mont. S. E. PIERCE has been appointed to succeed him.

L. H. KAPPLER, mining engineer, of Fairbanks, Alaska, is in charge of drilling work now being done on the Arolic River, 105 miles south of Bethel, Alaska, to determine whether it is suitable for dredging.

HENRY M. LANCASTER, mining engineer, who has recently been in charge of operations for the Lookout Mountain mine, in the Coeur d'Alene district, on Pine Creek, has been elected manager of the company.

A. J. KEAST, at present in charge of Continental Mines, at Kirkland Lake, which made a splendid drifting record during November, has been appointed resident manager of the Abana Mines, in the Rouyn district, Quebec.

E. E. WHITELY, assistant manager of Calumet & Arizona Mining, in the Bisbee district, recently went to Valedon, N. M., where he inspected the company's operations at the Eighty-Five mine, where a new shaft is being sunk.

E. S. MCCURDY, of San Francisco, and president of Nevada-Pacific Mineral, Inc., is in the Coeur d'Alene district. He is inspecting the properties of St. Joe Lead & Silver, which has a group of nine claims under bond and lease near Osburn.

P. P. GARCIA is in charge of work at the old San Miguel del Oro mine, in Zacatecas, Mexico, which has been abandoned for many years. A shaft is being sunk, and Mr. Garcia expects to construct a flotation mill for treating the low-grade ore now in sight.

RUFUS R. WILSON, president of Western Metals, spoke on the possibilities of the Northwest before the Northwest Mining Association at a luncheon at Spokane recently. C. R. SETTLEMIER, formerly of Keno City, Yukon, also spoke to the association.

G. B. ADENEY has been appointed manager of the Alaska Gold Dredging Company's operations on the Holt dredging lease, on Sullivan Creek, in the Hot Springs district. The ground covers 60 claims, which will be worked for gold and tin. These claims were recently purchased for $260,000.

A. C. BORGESON, mining engineer of Shenango Furnace Company, was elected president of the Northern Minnesota Engineers' Club on Dec. 15, succeeding H. T. Reifel, of Virginia, Minn. Joseph Wilson, of Eveleth, Minn., was elected vice-president, and W. L. Taylor, of Hibbing, Minn., was elected secretary-treasurer.

W. V. BUTLER, who recently returned to Minneapolis, Minn., from the Belgian Congo, expects to leave for Belgium in the latter part of February on his way back to the Congo. Mr. Butler has been in the northeastern part of the Congo for the greater part of the last twelve years, where he has been engaged in exploration work on concessions held by the Société Internationale Forestière et Minière du Congo and its associated companies. At present, Mr. Butler may be reached at 3,512 46th Ave. South, Minneapolis.

OBITUARY

WILLIAM CRIDERMAN, a pioneer prospector in the Coeur d'Alene district and other mining camps of the Northwest, died recently in Spokane. He was 82 years old.

MURRAY MORRIS DUNCAN, vice-president of Cleveland-Cliffs Iron and general manager of the mining department of the company, died at Ishpeming, Mich., on Dec. 17. Mr. Duncan had resigned his position as general manager of the company a few months ago because of ill health. He had been with Cleveland-Cliffs in various capacities since 1898. He was a graduate of Lehigh University in Pennsylvania. Mr. Duncan was 70 years old.

COLONEL C. P. TASKER, a graduate mining engineer of the University of Pennsylvania at the age of seventeen and a member of the Rough Riders under Theodore Roosevelt, died recently in Salt Lake City, Utah. For many years Colonel Tasker had been an active figure in Utah mining and oil affairs. His mining experience included examinations in Europe and Mexico. For several years he was employed by the U. S. Steel Corporation in a consulting capacity. He first came to Utah, about twenty years ago, to report on the state's iron-ore deposits and ever since that time he had made Salt Lake his home.

CHARLES V. WHITING, one of the pioneers in the boom days of Western metal mining, died at Salt Lake City on Dec. 16. Mr. Whiting was born in Utica, N. Y., on July 29, 1862. At the age of twelve he set out for the West to seek his fortune, and was among the first in Kit Carson, Colo., Carson City, and Virginia City, Nev., and Wood River, Idaho, when those famous camps were opened up. After amassing a considerable fortune, he went to Salt Lake City to live.

NEWS OF THE WEEK

Summary

THE litigation, which has lasted over a period of 30 years, between Mammoth Mining and Chief Consolidated over ore extraction from their adjoining claims in the Tintic district of Utah, has been ended with a verdict in favor of the former. Page 1035.

* * *

George Graham Rice has been sentenced to four years in the Atlanta penitentiary and fined $5,000. Serving of the sentence has been suspended, pending the appeal of the suit. Page 1036.

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A break in the relations between mine operators in the Oklahoma part of the Tri-State lead-zinc district and M. D. Hay, chief mine inspector, has been averted. Page 1033.

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The U. S. Bureau of Mines is conducting an extensive survey of the occurrence, mining, and metallurgy of quicksilver, through the Pacific experiment station at Berkeley, Calif. Page 1036.

* * *

British Columbia mineral production for the year and the high spots in mining and metallurgical developments have been summarized by J. D. Galloway. Increases over 1927 are indicated. Page 1032.

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Waite-Ackerman Montgomery is now shipping about 2,000 tons monthly from its mine in the Rouyn district to the Noranda smelter and a further increase in production is expected. Page 1035.

* * *

Shamrock Mines is resuming work at its properties in the old silver-gold camp of Ione, Nye County, Nev., which was a producer in the early 'sixties, when the Comstock Lode excitement was at its height. Page 1033.

Turner Describes Potash Drilling Work to House Appropriations Committee

By Paul Wooton
Special Washington Correspondent

WHEN Director Turner of the Bureau of Mines was before the Appropriations Committee of the House, undergoing the annual grilling to which all heads of bureaus are subjected, he was asked by the chairman of the committee if the large amount of money being expended by the government on potash exploration work is justified. Mr. Turner replied in the affirmative. He said further:

"There are many considerations to be kept in mind. In the first place, we had this great salt bed in the Southwest, known to be about 600 miles long and 250 miles wide and 1,000 ft. thick, from which no cores had been taken, from which only churn-drill cuttings had been recovered. No one had an accurate idea of exactly the occurrence of the geological horizons, or of the width or potash content of any of these potash horizons.

"This drilling has made available accurate information over a wide area, part of it on government lands. It has suggested the possibility of commercial deposits. It has demonstrated that diamond drilling can be done with high core recovery in this field, hitherto considered a difficult one to drill, and it has stimulated commercial companies to start similar explorations in this region. One company in particular is much interested in the government's program; this company has been doing some intensive drilling and reports very encouraging results.

"I think the plan, in the first place, was to be stimulative rather than actually accomplish much in the way of getting the government into potash production. I do not think the idea of the government's actually following up any of its finds was ever considered. This exploration encourages industry to search in the same field for commercial deposits, and underlying it all comes the question of the dependence of this country on foreign-produced potash, which production at present is administered under government monopolies.

"The results of the investigations thus far seem to indicate that the potash horizon is very widespread. We have found some potash in every hole. We have had as high as 50 potash horizons in one hole, and we have two holes which give some promise of commercial value. One of those holes has about 11 ft. of about 11 per cent potash and the other about 13 ft. of approximately 10 per cent potash. Those large widths show polyhalite, or calcium-magnesium-potassium salt, which is not readily soluble in water. Polyhalite is not being used as a basis for fertilizer at the present time. The potash produced in Germany and France is a water-soluble salt, a chloride which is more readily soluble. But we are not discouraged, because we believe that polyhalite may be made available by some relatively simple chemical process.

"Entirely outside of this appropriation we are conducting at our New Brunswick (N. J.) station, as a major problem, tests on polyhalite, recovered in these cores, with the idea of making the contained potash available as fertilizer material.

"The program is continuing satisfactorily. The deepest hole was 2,098 ft. and the shallowest hole exactly 1,000 ft. The core recovery has been good—astonishingly good—and, after all, what we are after is core which we can analyze and examine. In the last seven holes the average core recovery was 100 per cent. The cost of putting down these test wells has decreased steadily, until we are now approaching a reasonably low figure. The cost of this drilling may seem relatively high, but that is because we are moving the equipment long distances, the holes being many miles apart. We are drilling under difficult conditions as to fuel and water supply, and we are operating under the provision that the final core at the bottom of the hole must not be less than 2½ in. in diameter."

Tri-State Mines Close for Holiday Week

Practically all the major producers of the Joplin-Miami zinc and lead field closed their properties Saturday, Dec. 22, for the Christmas holidays. The mines will be reopened on Monday, Dec. 31. It is expected that the normal weekly output of the field, amounting to 12,750 tons, will be reduced more than 75 per cent for the week.

Mineral Production of British Columbia Increases During 1928

THE Department of Mines of British Columbia has just issued a preliminary estimate of the mineral production and summary report of the mining industry of British Columbia during 1928, compiled by J. D. Galloway, Provincial Mineralogist. Besides Mr. Galloway's summary, each of the six resident mining engineers gives a report of his district, and James Dickson, Chief Inspector of Mines, gives a brief survey of the coal industry.

The estimated tonnage of ore treated is 5,700,000 tons, compared with 5,416,021 in 1927.

An important feature that does not show in the figures of production, though it may be expected to in future years, is the large amount of exploration that has been done on both new properties and on old and often long-abandoned mines.

Mr. Galloway believes the chief features of the year's development in mining to have been:

1. The important results attained in the Pend Oreille area, which lies partly in British Columbia and partly in the State of Washington. This is an area of widespread, low-grade mineralization, which seems destined to be a large producer of zinc and lead. The development at the Reeves-McDonald property gives a key to the possibilities of the field. Profitable operation in this area, however, will be more than usually dependent on the trend of metal prices.

2. The strike, at considerable depth, of an important sheet of silver-lead ore in the Noble Five mine, at Sandon.

3. Success in the development of the Monarch mine, at Field, with the practical assurance that a concentrator will be erected next year.

4. Renewed interest in the Cadwallader Creek gold camp, where the Pioneer mine is producing from substantial ore reserves and the Lorne and other properties are being extensively developed.

5. Satisfactory development of the Ferguson silver-lead mine, on Ingenika River.

6. Successful results at Duthie Mines, with consequent installation of a new power plant and other improvements.

7. Discovery of high-grade ore on the Mountain Boy property, at Stewart.

8. Intensive campaign of development and equipment by the Premier company on three new properties which it recently acquired—the Prosperity, Porter-Idaho, and Silverado.

9. The development option taken on the Toric mine, situated near Alice Arm, by Howe Sound.

10. Continued expansion of production by the three major copper producers. Britannia, Anyox, and Copper Mountain.

11. Success attending diamond-drilling campaign at the Kootenay King property, which has resulted in a development operation having been taken on it by the Howe Sound company.

12. The number of old mines that during the year have given definite indication of being revived to active production.

Mr. Galloway considers the outstanding feature in prospecting during the year has been the more common use of various electrical devices. He points to the following as the most important developments of the year in metallurgy:

1. Extension of Sullivan mill capacity from 4,000 to 6,000 tons a day.

2. Successful operation of five new mills in the Slocan district.

3. Announcement of West Kootenay Power & Light Company's construction of a new hydro-electric power plant on Pend Oreille River to produce 75,000 to 80,000 hp.

4. Construction of 100-ton addition to electrolytic zinc plant at Trail.

5. Production of metallic cadmium at the Trail plant and production of bismuth on a semi-commercial scale.

6. Successful culmination of research work at Trail, whereby large tonnages of zinc-plant residue and zinc slags, which have been accumulating for years, will be profitably re-treated. Starting of the new South Slocan plant of the West Kootenay company, with an output of about 75,000 hp., will give Trail additional power to begin this re-treatment and carry out other plans. Trail is now in the position of having its research work several years ahead of its power supply and plant construction. These plans embrace the manufacture of fertilizers and of steel products.

The disbursement of dividends from the year's operations in British Columbia is expected to reach approximately $11,500,000.

British Columbia Mineral Output in 1927 and 1928

	Production, 1927		Estimated Production, 1928	
	Quantity	Value	Quantity	Value
Gold, placer, oz.	9,191	$156,247	5,883	$100,000
Gold, lode, oz.	178,001	3,679,601	192,000	3,968,640
Silver, oz.	10,470,185	5,902,043	10,570,000	6,155,228
Copper, lb.	89,202,871	11,525,011	99,150,000	14,524,483
Lead, lb.	282,996,423	14,874,292	318,000,000	14,535,780
Zinc, lb.	145,225,443	8,996,135	162,000,000	8,850,060
Coal, tons (2,240 lb.)	2,453,827	12,269,135	2,510,300	12,551,500
Structural materials	.....	2,867,380	.....	3,100,000
Miscellaneous minerals and metals	.....	459,514	.....	900,000
Totals	.....	$60,729,358	.....	$64,685,691

Copper Queen Wins November Phelps Dodge Safety Contest

The Copper Queen branch of Phelps Dodge, in the Bisbee district, led the three other units of the corporation and affiliated companies in the safety contest during November. Only two lost-time accidents were recorded at this branch. The other units achieved the following records: Moctezuma, two; Old Dominion, one; and Morenci, five. Old Dominion, although it has the fewest number of accidents, does not employ as many men as either the Copper Queen or Moctezuma branch, and therefore did not rank as high from a percentage standpoint. For the year to date, honors are about evenly divided between Morenci and Moctezuma, with the latter having a slight advantage, its percentage being 0.044, compared with the former's 0.045.

Chibougamau Mine Will Continue Work During Winter

Obalski Chibougamau Mining has announced an aggressive campaign of further exploration on its holdings at Cache Bay and Portage Island, in the Chibougamau district, Quebec, during the coming winter. Gold and copper outcrops have been encountered on four parallel veins at the Cache Bay claims. Engineers have proved mineralization extending over 7,000 ft. on the 28 claims in McKenzie Township and 8 in Roy Township. About 2,500 ft. of mineralization has been indicated in 13 veins on Portage Island. Extensive drilling will be carried out on the Cache Bay property. By February work should also be under way at Portage Island.

Reopen and Re-equip Old California Mine

Alta Gold Mining, of which Herman Budan is president and general manager, has purchased the old Alta mine, which has not been worked for 32 years, in Amador County, Calif., and will reopen and re-equip the property. Mr. Budan recently announced that his present plans call for the installation of mining equipment, including an electric hoist and a small ten-stamp mill. The property is developed by a 350-ft. shaft, most of which is under water.

No Bidders for Matchless

On Dec. 18, the Matchless mine in the Leadville district of Colorado, one of the properties of the late U. S. Senator H. A. W. Tabor, was put up at auction because the taxes, $25.65, were unpaid, and there were no bidders. It will be kept on the delinquent list in the hope that eventually the taxes will be paid. Last July the Shorego Mining company foreclosed a $15,000 mortgage against it.

The old Ione district in Nevada as it appears today

To Resume Work in Old Nevada Silver-Gold Camp

Ione, Nye County, Nev., which was a producer of gold, silver, and quicksilver in the early 'sixties, at the height of the Comstock Lode excitement, will be the scene of renewed operations by Shamrock Mines. Driving of the main tunnel has already been resumed in an effort to reach the extension, at depth, of the Old Keystone and Indianapolis orebodies, from which considerable amounts of silver were produced. Two leasers have started work in the Indianapolis shaft. The Shamrock holdings are equipped with an Ingersoll-Rand ten-drill compressor, a small mill, and other necessary surface buildings.

Break Between Inspector and Tri-State Producers Averted

A BREAK in the relations between the mine operators of Oklahoma and M. D. Hay, chief mine inspector, which seemed imminent following the issuing of an order requesting operators to eliminate "jump-cribbing" in all shafts in which men were handled, and to equip all hoists with location indicators, has been averted. Inspector Hay called a meeting of the operators of the Oklahoma section of the Joplin-Miami field last week, at which the new mining code for Oklahoma was the main subject for consideration, but at which the order was discussed and adjusted to the satisfaction of both miners and the inspector.

Operators realize the danger of "jump-cribbing" and are willing to eliminate this accident hazard in their mines to the entire satisfaction of Inspector Hay, who in turn modified his order so that no undue financial burden would be thrust upon operators in making changes. Inspector Hay also explained that he would insist only upon hoisters being equipped with location indicators, and not speed and location indicators.

Differences of opinion still exist between some of the operators and Inspector Hay in regard to several clauses in the proposed mining code, which is to be presented to the Oklahoma Legislature for consideration on Jan. 8.

More than a year ago, Governor Johnson appointed a commission of four Oklahoma mining men, two from the coal fields and two from the metal mines, to revise the mining laws of the state, of which Inspector Hay was made chairman. The coal miners drew up a tentative code covering the coal-mining industry of the state, and the metal-mining members, Charles Neal and John W. Newton, drew up a tentative code for the metal-mining industry.

Inspector Hay, as chairman of the committee, with the help of the coal members, revised the two tentative codes into a single code. In the revision, Inspector Hay eliminated that section of the metal-mining code calling for the election of the deputy mine inspectors and a clause calling for the appointment of a board of review, whose duties, under the Neal and Newton interpretation, would be to hear any grievances that might arise between the inspector and the mine operators.

It was known that Inspector Hay would object to the election and board of review clauses before the meeting here. There was talk of Neal and Newton presenting a minority report to the Legislature in case Inspector Hay insisted on eliminating those sections relating to election and board of review.

Newton and Neal had practically no assistance from the mine operators in drawing up the tentative code, and consequently believed the miners approved of their work. Many of the operators recognize the soundness of Inspector Hay's changes, and probably will insist that they be made.

Frank Childress, president of the Tri-State Zinc and Lead Ore Producers' Association, has called a general meeting of operators, at which an effort will be made to get the operators to agree on some plan that will meet the approval of Inspector Hay.

Silver Age to Explore Holdings in Ely District

SILVER AGE MINING company will put down a churn-drill hole on its property near Lane City, Nev., three miles from Ely, to ascertain if the sedimentaries do not underlie the porphyry, believed to be a sill extending from the Nevada Consolidated Copper property.

Silver-lead ore worth $80,000 has been taken from the property down to the 200 level in the upper limestones. The company is also driving a drift north from the bottom of the Bullion shaft, seeking the downward and western extension of the orebodies productive in the upper levels. W. J. Walker, superintendent, is in charge of operations.

Long Tramway, in Silverton District, Is Completed

DRESSER MINING, operating in Cunningham Gulch, near Silverton, Colo., has completed its 5,300-ft. cable tramway, which connects the Garry Owen mine with the Old Hundred mill. This plant will be re-equipped and put into operation in the spring. In addition to the Garry Owen mine, from which most of the tonnage for the concentrator will be obtained, the company owns the Veta Madre mine. C. M. Lane is in charge.

Mr. Lane is also interested in Pride Mining & Milling, which has finished construction of a mill building in the same district. Machinery is now being installed in the building. A test run of the plant will probably be made about Jan. 10. At the mine, developments on the No. 5 level have progressed favorably.

Operations Started at Olive Branch Mine, in Butte

Butte Olive Branch Mines, which was recently formed to acquire the Olive Branch, Black Hawk, and other claims in the southwestern part of the Butte district, has started operations under the supervision of W. C. Siderfin, who was connected with the Clark interests for many years. F. Cushing Moore, of Spokane, is consulting engineer. Former operators produced about $400,000 in silver-zinc ore from the Olive Branch claim. The property will be equipped with modern electric machinery.

International Nickel Orders Eight New Rod Mills

International Nickel has placed orders for new machinery with the William Hamilton Company, of Peterborough, Ont. Among the items of new equipment are eight rod mills to be installed in the concentrator at Copper Cliff. Extensive pumping equipment is also included. Delivery is to be made in June, 1929.

Leasers Make Strike at Tom Reed Gold

EYSTER and James report that they have found a new orebody in their lease on the 300 level of the Ben Harrison claim of the Tom Reed estate at Oatman, Ariz. The new vein has been opened for a length of 70 ft. It contains 4 ft. of gold-bearing quartz, averaging $35 to the ton. This lease shipped 150 tons of ore to the mill last month. The Tom Reed mill is handling only 60 tons per day, because the winze below the 800 level encountered so much water that it had to be stopped. As soon as another pump can be installed sinking of the winze will be continued to the 1,100 level. The Black Hawk shaft, sinking of which was also stopped on account of water, will then be sunk to the same level and will be connected with the winze by a drift.

Butte Copper Shaft Reaches No. 5 Level

Sinking of the new Butte Copper Consolidated shaft, at the company's Joe Dandy mine, near Radersburg, Mont., between Helena and Butte, has reached the No. 5 level of the mine. Lateral work at that level has already reached the No. 1 orebody, and the operators expect that Nos. 2 and 3 orebodies will be reached this week. To date the company has shipped 60 carloads of high-grade silver-lead ore from above the No. 4 level of the mine.

Smuggler Union Is Sold

The Smuggler Union mine, at Telluride, Colo., has been purchased by Ben and Max Grimes, of Denver. This mine, which had been operating for 53 years and which is credited with a production record of about $55,000,000, was closed down by the operating company, Smuggler Union Mining, a Boston organization, because of exhaustion of ore reserves and increased costs resulting from the fire in the surface buildings at the mouth of the Pennsylvania tunnel in October, 1927. The mine, in addition to a 4,500 ft. cable tramway, had an 800-ton flotation mill.

Resume Work on Two Gowganda Mines

WORK on the Silverado and Hudson Bay properties, in the Gowganda district, Northern Ontario, will be resumed by the Pioneer Prospectors Consolidated Mines, Ltd. The Hudson Bay produced high-grade ore in the earlier days of the camp, and was purchased by the present holders for a reported price of $200,000. There are two shafts on this property, down 190 and 220 ft., respectively. At the Silverado a depth of 110 ft. has been attained. Equipment is already installed at the Silverado, and will soon be taken into the Hudson Bay property.

Dr. George Otis Smith Discusses the Government and the Mining Industry

THE government's aid, or intent to aid, the mining industry was the topic of Dr. George Otis Smith, Director of the U. S. Geological Survey and President of the A.I.M.E., at the Machinery Club, in New York, on Dec. 20, when he addressed the New York Section. With respect to the general relationship of government to industry, Dr. Smith said that there is general agreement that there should be no interference on the part of the former. This is a theory, and in practice it is not easy to distinguish at times between interference and helpfulness. He referred to the mine safety work of the Bureau of Mines as an example of government aid. The Bureau has done nearly all that can be done. He added that where the operators want something done they are glad to have all the powers of the federal government brought to bear, and often like to see it take the initiative.

One of the duties of the Geological Survey is the collection of mineral statistics, the speaker said. In the course of this work from time to time the question of the government's authority to gather the figures crops up. This, however, is an academic question. The Survey does not regard this as interference, nor is it so looked upon by the industry.

There has been some criticism of late, said Dr. Smith, to the effect that the Survey is not doing the work it used to do. This is true. It lacks the money, and therefore does not have the men. One of the troubles of geological work, as done by a government agency, is that it does not bring in immediate returns, so that it is difficult to show the "men on the hill" what has been done with the appropriation granted the previous year, and so convince them that the new request for funds is justified. The people in the Bureau of the Budget apparently think that research blooms annually, said Dr. Smith, and yields results in three or four months. Instead, he said, it is a perennial, and sometimes, he thought, a century plant.

The present tendency in the work of the Geological Survey in mining geology is to make it more intensive and to direct it in one general direction—namely, to help find the ore. Dr. Smith said he knew that in some cases the tips of the Survey to owners had resulted in finding ore and had paid back the cost of the work many times. As for the future, the consumption of metals, already great, is increasing rapidly, and will become even greater, and it is one of the tasks of the Survey to find new supplies. Industry is setting a fast pace; it is the peculiar task of the mining industry to keep up with that pace.

Dr. Smith then referred to the Institute as an open forum, and said that it affords members the opportunity to come together and discuss common problems in a free and open manner. The topic of "Production Control" is to be taken up at the February meeting. It should be discussed by the members, who get their facts at first hand, rather than by economists, who get them second hand, he believes.

The Survey is not only a consu'ting engineer to the public in several ways, but in a special sense it is a staff engineer to the government. The speaker cited the Survey's work in supervising the oil wells and mines on public land to illustrate his meaning. This and other examples of production engineering are representative of the work that the government is doing. In conclusion, Dr. Smith said that the general sentiment in the mining industry is that the government should spend more on behalf of that industry. He urged the members present not to hesitate to tell this to anyone they happen to know in Washington.

When the meeting was thrown open for discussion, Sidney Ball asked Dr. Smith how the work of completing the topographic map is progressing. Dr. Smith replied that although the government was not followed the authority granted by the Temple Bill, the situation is nevertheless better. Not as much progress is being made as is desired, but the rate of work is being increased. The policy of matching all state and local financial co-operation that is offered has been confirmed.

Before the meeting adjourned, the chairman, Sidney Rolle, called upon W. G. Swart, of Duluth, to tell how things were going in the iron industry. Mr. Swart replied with a brief review of the situation. The last five years have been pretty severe, but conditions are getting better. This year's production of about 52,000,000 tons has come mostly from the big producers, despite lessened costs. He laid stress on the great increase in the amount of ore beneficiated.

Spokane Man Buys Two Mines in Nayarit, Mexico

R. K. Neill, of Spokane, has purchased two properties in Nayarit, Mexico, which carry silver-gold ore, and has formed the Morada Mining Company, with a capitalization of $3,000,000 in $1 shares, to operate the mines. According to Mr. Neill, neither mine has been exploited below the 325 level, and among the initial steps taken by the company will be the sinking of new shafts, one on each property, to a depth of 600 ft. From these shafts, three levels will be driven toward the orebodies. A central power plant and a new mill are also planned. Mr. Neill will leave for Nayarit within the near future to superintend operations personally.

Chief Consolidated Wins Long Suit From Mammoth Mining

CHIEF Consolidated Mining has won its suit, of 30 years' standing, against the Mammoth Mining Company as the result of a decision handed down recently by the U. S. Circuit Court of Appeals, at St. Louis. The amount involved is about $200,000, according to attorneys in the case. The following account is taken, in part, from the Salt Lake *Tribune:*

The Mammoth Mining Company of Nevada "is the owner of four lode mining claims in the Tintic mining district of Utah, known as the First Northern Extension of the Mammoth, the Jenkins, the Golden King and the Bradley."

The appellant, the Chief Consolidated Mining Company, in the same district "owns two claims, the Silveropolis and the Consort. It acquired these two claims by purchase from the Grand Central Mining Company, a Colorado corporation."

On May 9, 1902, the Mammoth and Grand Central started suit simultaneously. The Grand Central charged the Mammoth, under claim of apex, with trespass and extracting ores from beneath the Silveropolis and Consort claims.

The Mammoth, in its suit, sought to quiet its title to "the same portion of the vein and orebody vertically beneath said Consort and Silveropolis mining claims by virtue of the claim that the apex of said vein was within the Jenkins, Golden King and Bradley mining claims."

Both suits were consolidated in November, 1902, but trial was stayed until a determination of an action then pending in the Utah supreme court involving the apex question. This action had been begun in 1899.

Finally, the record shows, the trial court found in favor of the Grand Central. On appeal to the Utah supreme court this decision was affirmed Oct. 11, 1905.

Meantime, the duel between the Grand Central and Mammoth in the United States district court at Salt Lake rested, with the exception that on Feb. 15, 1904, "the Mammoth company tendered an issue as to the surface boundaries of the Bradley lode mining claim in relationship to the boundaries of the Consort." Until this was determined, there could be no accounting between the Mammoth and Grand Central for the alleged trespass.

The record shows further that on March 15, 1911, the federal judge, at that time John A. Marshall, directed an examiner to take testimony. The issue was considered in 1914, "but for some unexplained reason no judgment or decree was signed or entered; thereafter no action appears to have been taken until March, 1924," when the court, in clearing its docket, demanded the case be tried or dismissed.

Neither side objected, and the boundary suit was heard. On Aug. 2, 1924, a decree was entered "defining the boundaries of the mining claims and quieting title to certain property therein described in the Grand Central against all claims of the Mammoth. Upon appeal by the Mammoth, this decree was affirmed May 24, 1926."

Meanwhile, the Chief Consolidated had made a showing that it was the successor to the Grand Central, having purchased the property in 1922.

On top of that, the Mammoth came back with a showing that on Dec. 28, 1906, the Mammoth Mining Company of Utah had sold out to the Mammoth Mining Company of Nevada. Either this had been discovered by the opposition or it lay for years, to come up as a surprise.

On Sept. 9, 1927, the Chief Consolidated sought to supplement as defendant, the Mammoth of Nevada, the successor to the Mammoth of Utah, but United States Judge Tillman D. Johnson, in Salt Lake, denied the motion. It was further decreed in the same order that the accounting, whatever it was to be, should not be permitted to cover any period later than Dec. 28, 1906.

From Judge Johnson's decision, the Chief Consolidated appealed to the circuit court of appeals, with the Mammoth filing a cross-appeal from that part of the decree awarding an accounting against it.

Circuit Judge VanValkenburgh concludes his opinion by saying "the case on the main appeal is reversed and remanded with directions that the supplemental bill of the Chief Consolidated Mining Company be allowed and that the Mammoth Mining Company of Nevada be made a formal, as it is now an actual, party to the record. The cross-appeal of the Mammoth Mining Company of Utah is reversed in so far as the decree below limits the accounting to Dec. 28, 1906. The accounting prayed will proceed in accordance with the interests and obligations of the parties, as they may be disclosed, and with the views in this opinion expressed."

Michigan Mine Saving 3 Lb. Per Ton With Flotation

Mohawk Mining, in the Michigan copper district, is obtaining good results from the treatment of tailing with the Fahrenwald flotation process. With one machine, which is treating about 40 per cent of the tailing from one stamp, a recovery of better than 3 lb. per ton is being obtained. This saving presages a wider use of the process in the Mohawk mill. Mohawk's production was down somewhat in November, when 1,600,000 lb. of refined copper was produced. No. 6 shaft continues to yield the largest part of the tonnage.

Hoover on Committee for Kemp Memorial Fund

PRESIDENT-ELECT HERBERT HOOVER is a member of a committee of more than fifty American scientists and engineers who have initiated a movement to perpetuate the name of the late James Furman Kemp, for 34 years a professor in Columbia University. The committee, of which Walter Douglas has been appointed chairman, seeks to establish a Kemp Memorial Fund providing an endowment for research and publication in economic and structural geology.

"The aim of the fund," the announcement explains, "is to promote studies of an advanced and original character, preference being given to problems in economic and structural geology, the field in which Professor Kemp made noteworthy contributions."

John A. Church, Jr., is vice-chairman of the memorial committee and Chellis A. Austin is treasurer. Members, in addition to Mr. Hoover, who was long an associate of Professor Kemp in organized engineering, are:

Edward D. Adams, Frank D. Adams, Walter H. Aldridge, H. Foster Bain, A. Chester Beatty, Paul Billingsley, Stephen Birch, N. L. Britton, Nicholas Murray Butler, William Campbell, Louis S. Cates, Charles W. Clark, Milton L. Cornell, Clinton H. Crane, E. L. DeGolyer, Gano Dunn, Arthur S. Dwight, Karl Eilers, B. K. Emerson, F. Julius Fohs, Kingdon Gould, John Hays Hammond, Louis D. Huntoon, Daniel C. Jackling, Arthur Curtiss James.

Also, Douglas W. Johnson, Cornelius F. Kelley, Thomas H. Leggett, C. K. Leith, Waldemar Lindgren, John C. Merriam, Harvey S. Mudd, R. V. Norris, Henry Fairfield Osborn, Edgar Palmer, George B. Pegram, R. M. Raymond, J. V. W. Reynders, T. A. Rickard, Heinrich Ries, Reno H. Sales, George Otis Smith, Thomas B. Stearns, George C. Stone, Lester W. Strauss, Benjamin B. Thayer, Matthew Van Siclen, Arthur L. Walker, David White.

Waite-Ackerman Shipments Now 2,000 Tons Monthly

SHIPMENTS from the Waite-Ackerman Montgomery mine, in the Rouyn district, Quebec, to the Noranda smelter, are now at the rate of 2,000 tons of ore a month. Part of this shipment is smelting ore and is sent directly to the smelter; the rest goes to the new 500-ton Noranda concentrator. Tonnage shipped will probably soon be increased.

At the mine, raises are being driven to the orebody at the first level, a depth of 185 ft., to enable increased production. On the second level, at 300 ft., a crosscut is being driven under the orebody that is being worked on the level above. Exploration by diamond drills on this level is to be started. Glory-hole methods of mining will be used.

Interest Reawakened in Zircon Deposits in Brazil

ACCORDING to a report from Claude I. Dawson, American consul general at Rio de Janeiro, considerable interest has developed in the State of Sao Paulo, Brazil, over extensive deposits of zircon ore that occur there. These deposits are said to average 73 per cent zirconium dioxide.

The uses for zirconium which have heretofore been responsible for the largest consumption include its application in refractories, in incandescent gas lighting and electric arc lights, and as an abrasive. As a desulphurizing agent in steel it combines with sulphur, thus increasing the capacity of manganese to combine in the steel. According to the U. S. Bureau of Mines, zirconium oxide has come into use as a substitute for tin oxide in ceramic glazes. The substitution is said to effect considerable economy and to result in a ware equal or superior in quality to that produced with tin. The zirconium oxide thus used is obtained from zircon, as a byproduct in the production of titanium oxide, zinc oxide, and lithopone, and a substitute for white lead.

Mexican Premier to Operate at Capacity About Jan. 1

OPERATIONS of the 100-ton flotation plant of the Mexican Premier Mines, in the Copala district, Sinaloa, Mexico, are expected to reach capacity about Jan. 1. The plant was damaged during September by a severe storm. Repairs and replacements are now being made, according to Raymond Guyer, president of the company. Despite the fact that operations have been impeded, November production was 117 tons of high-grade concentrate, averaging more than 400 oz. in silver, about 0.80 oz. in gold, and 35 to 40 per cent lead. Concentrate is shipped from the station at Presidio to the Asarco smelter at San Luis Potosi. December production is expected to be about 150 tons of concentrate. The properties are operated by a subsidiary company, known as Compañia Minera de San Jose.

In the Oct. 13 issue, the statement was made that the company is undertaking to construct a lead smelter at its properties. *Engineering and Mining Journal* has since been informed that the company does not at present plan to build such a plant.

Rice Sentenced to Four Years in Jail and Fined

On Dec. 21, Federal Judge Knox, sitting in New York City, sentenced George Graham Rice, mining stock promoter, to four years in the federal penitentiary in Atlanta, and imposed a fine of $5,000, and a probationary period of five years following the completion of his prison term. Walter K. Yorston, his associate in the promotion of the Idaho Copper Corporation, was sentenced to nine months in the Westchester County penitentiary and a similar period of probation. The "Wall Street Iconoclast," the publication which the government proved used the mails with intent to defraud, was fined $10,000. No sentence was pronounced on the Idaho Copper Corporation, which was also convicted, pending a period of five years. Judge Knox stated that if he learns of any malpractice by the company during this period he will impose heavy sentences.

Rice's attorneys announced that an appeal would be made, and, pending this appeal, Rice was admitted to $5,000 bail and execution of all sentences was stayed until Jan. 3.

Walter Harvey Weed, who had been indicted with Rice, was acquitted by the trial jury.

Idaho School of Mines Has Record Enrollment

WITH an enrollment of 51 the University of Idaho School of Mines, at Moscow, Idaho, has the largest attendance in its history. Twenty-five offers of positions in the mining industry to recent graduates of the school have been made since June 15. These offers come from companies in many countries, from Canada to Ecuador. The most recent was a telegraphic request from Alaska wanting a mining man at once. The 1927 class of the School of Mines totaled six, and the offers averaged four for each graduate. It is impossible to meet the demands, but names of graduates of former years have been sent in response to inquiries.

Position of Metallurgist With Government Is Open

The U. S. Civil Service Commission announces an open competitive examination for the position of senior physical metallurgist, at a salary of $4,600 a year. A vacancy in the Bureau of Standards, Department of Commerce, at Washington, and vacancies occurring in positions requiring similar qualifications, will be filled from this examination. Applications must be on file with the Civil Service Commission at Washington, D. C., not later than Jan. 23, 1929.

Dobson Mine Is Purchased

C. C. Cole and associates, of Tulsa, Okla, have purchased the Dobson mine, southeast of Hockerville, Okla., in the Joplin-Miami district, from Federal Mining & Smelting Company, for an unannounced consideration, said to be more than $200,000. Cole and associates, who own the Farmington mine of Dorothy Bill Mining Company, on land adjacent to the Dobson lease, had an option on the property for several months, during which time they have drilled a number of holes, which are reported to have justified the exercise of the option.

Bureau of Mines Studying U. S. Quicksilver Industry

AN extensive survey of the occurrence, mining, and metallurgy of quicksilver in the United States is being undertaken by the Pacific experiment station of the U. S. Bureau of Mines at Berkeley, Calif. Need has been felt in the quicksilver industry for comprehensive research such as the Bureau can perform. No official studies of occurrence and mining methods have been made heretofore, and the latest metallurgical pamphlet on the subject was written in 1925, since which time rapid advances have been made in this field. Curt N. Schuette, who has taken a prominent part in quicksilver investigation, is conducting the work under the direction of C. G. Maier, supervising engineer at the Berkeley station. Mr. Schuette is now in the field and expects to visit all the active producing areas in this country within the next six months. This work is particularly timely, now that the price of mercury has been artificially raised by the Spanish-Italian agreement.

Once ground is gained by the American producers, who have been hampered by relatively high costs and low returns, hope is held out for the retention of a larger part of the domestic market. The next move of the foreign producers is, however, difficult to predict, as their Lausanne selling agency is releasing no information of stocks on hand or projected activities.

Contract Signed for Zinc From Pyrites Plant

Krebs Pigment & Chemical Company, of Newport, Del., has signed a contract whereby it agrees to purchase the entire zinc output contained in liquors from the Pyrites Company, of Wilmington. The material purchased is derived through the leaching of certain ores and is produced in the form of liquor which contains other constituents in addition to zinc. It will be used in the manufacture of lithopone.

Arcadian Drift Obtaining Favorable Results

Good copper ground is again in evidence in the south drift of the New Arcadian vein at the 1,700 level of the New Baltic shaft, of Arcadian Consolidated, in the Michigan district. This drift showed good copper content for a distance of 200 ft., when it entered a broken area which extended for a considerable distance. Practically the same condition obtained in the north drift of the same level. The vein is of good width, extending from foot to hanging in the drift. Four drills are at work. The same New Arcadian vein was partly developed from the New Arcadian shaft 3,500 ft. distant. It shows continuity, with good stretches of copper ground intervening.

MARKET AND FINANCIAL NEWS

December Dividends Establish New High Record

By Homar L. Johnson
Assistant Editor

THE total of December dividend disbursements provides a fitting climax to a year of record-breaking mining dividend totals, by establishing a monthly dividend disbursement approximately $11,500,000 in excess of the previous monthly record. December, of course, has always been favored for special and extra dividend payments, because of the Christmas influence and the fact that the approach of the new year permits a recapitulation of profits that, where operations have been particularly successful, frequently results in anticipatory additions to regular dividend payments.

Increased earnings of copper producers continues, in large measure, responsible for the increase in the monthly aggregate of dividend disbursements by North and South American mining companies. Dividend totals reported during corresponding months of the last eight quarters are compared in the accompanying table:

	1927	1928
March	$27,517,175	$32,299,402
June	34,142,501	33,828,275
September	32,308,142	34,481,226
December	34,512,054	46,129,41
Average	$32,119,968	$36,684,580

Comparing the dividend lists of December, 1927, and December, 1928, four companies are absent from this year's list—namely, Betty O'Neal Mines, Caledonia, Eagle-Picher, and Nipissing. Hecla, Mother Lode Coalition, and Hollinger have decreased their dividend rates. Of these seven companies, only one—Mother Lode Coalition—is a copper producer, and its lower dividend rate is accounted for by decreased earnings resulting from a lower production.

The good news in the form of higher dividend payments and additions to the list, however, exceeds the bad, quantitatively as well as qualitatively. Twelve of the fifteen companies directly interested in copper production or reduction —Calumet & Arizona, Calumet & Hecla, Isle Royale, Mohawk, Nevada Consolidated, Nichols Copper, St. Mary's Mineral Land, Tennessee Copper, Utah Copper, Andes, International Nickel, and Chile Copper—made larger dividend distributions this month than they did a year ago, four of these twelve companies—Isle Royale, Nichols Copper, St. Mary's Mineral Land, and Andes—having made no payment in December, 1927. Nichols Copper resumed dividend payments in 1928 after a lapse of twelve years and Andes' payment constitutes its initial distribution. Thus, American Smelting & Refining, and American Metal are the only companies with important copper interests whose dividend rates have not been increased in the last year.

Getting away from the coppers, the improvement is less marked. Except for Great Northern Iron Ore's $2 per share disbursement, totaling $3,000,000, new and increased dividend payers contribute less to the total than was deducted because of decreased payments by other companies. Rico Argentine, Sunshine Mining, and Mining Corporation of Canada were not on the December, 1927, list, though each made regular payments during 1928. Lake Shore Mines contributed a quarterly and an extra payment of 20c. per share last year, whereas this month an additional extra payment of 20c. per share, making the total 40c., has been distributed. New York & Honduras Rosario paid a Christmas bonus of 25c. per share, and Patiño Mines & Enterprises announced an interim dividend of 4s. per share. Otherwise all payments are at the same rate as that prevailing a year ago.

Granby Consolidated Mining, Smelting & Power Company stockholders met on Dec. 27 to vote on a proposal to increase the company's reserve fund for depreciation and depletion from $3,173,051, at which figure it stood Dec. 31, 1927, to $4,026,593, the transfer to be made from current assets.

E.&M.J. Compilation of Mining Dividends and Yields for December, 1928

Companies in the United States	Situation	Per Share	Total	Per Cent Annual Yield
American Metal	U. S. and Mex.	$0.75 Q	$446,127	5.5
American Metal, 6% pfd.	U. S. and Mex.	1.50 Q	150,000	5.2
American Smelting & Refining, pfd.	U. S. and Mex.	1.75 Q	875,000	5.1
Bunker Hill & Sullivan, s, l	Idaho	0.75 MX	245,250	7.0
Butte & Superior, z, s	Mont.	0.50 Q	145,099	20.5
Calumet & Arizona Mining, c	Ariz.	2.50 XXX	1,606,892	6.4j
Calumet & Hecla Consolidated, c	Mich.	1.00 Q	2,005,502	9.9
Federal Mining & Smelting, pfd., s. l, z	Idaho, Okla.	1.75 Q	210,000	7.1
Golden Cycle Mining & Red., g	Colo.	0.04 Q	60,000	10.3
Great Northern Iron Ore	Minn.	2.00 SAX	3,000,000	11.4j
Hecla Mining, l, s	Idaho	0.15 Q	150,000	3.8
Homestake Mining, g	S. D.	0.50 M	125,580	9.1j
Inland Steel	Minn.	0.625 Q	739,249	3.7j
Isle Royale, c	Mich.	0.50 X	75,000	7.3j
Mohawk Mining, c	Mich.	3.00 XX	345,000	13.6j
Mother Lode Coalition, c	Alaska	0.20 SA	500,000	....
National Lead	U. S.	1.25 Q	387,289	4.2
National Lead, pfd. "A"	U. S.	1.75 Q	426,433	5.0
Nevada Consolidated Copper	Nev., Ariz., N. M.	0.50 Q	2,427,555	5.9
New Jersey Zinc	Various	2.00 X	981,632	4.7j
Nichols Copper	N. Y.	0.50 SA	35,000	....
Republic Iron & Steel	U. S.	1.00 Q	300,000	5.2
Rico Argentine Mining, s, l, z	Colo.	0.03 Q	24,000	26.1
St. Joseph Lead, l, z	Mo., N. Y.	0.75 QXX	1,462,821	5.4
St. Mary's Mineral Land, h	Mich.	1.00 X	160,000	8.3
Sloss-Sheffield Steel & Iron	Ala.	1.50 Q	150,000	5.1
Sunshine Mining, s, l, z	Idaho	0.02 BM	30,000	9.3
Tennessee Copper & Chemical	Tenn.	0.25 Q	198,656	5.8
Texas Gulf Sulphur	Texas	1.00 Q	2,540,000	5.6
Tintic Standard, s, l, z	Utah	0.20 Q	230,583	11.2j
Silver King Coal, s, l, z	Utah	0.10 X	122,047	8.2
U. S. Steel	U. S.	1.75 Q	12,453,411	4.6
Utah Copper	Utah	3.00 Q	4,873,469	5.1
Vanadium Corporation	Various	1.00 X	378,367	4.5j
Companies in Other Countries				
Andes Copper	Chile	0.75 I	2,320,352	....
Chile Copper	Chile	0.75 Q	3,311,623	4.8
Hollinger Consolidated Gold	Ont.	0.05 FW (2)	492,000	7.7
International Nickel, n, c	Ont.	0.75 Q	1,255,038	1.5
Lake Shore, g	Ont.	0.40 QX	400,000	5.9j
Lucky Tiger-Combination, g, s	Sonora	0.12 MXX	33,382	11.9j
McIntyre-Porcupine, g	Ont.	0.25 Q	199,500	5.0
Mining Corp. of Canada	Ont.	0.125 SA	207,560	6.8
N. Y. and Honduras Rosario, g. s	Honduras	0.25 X	50,000	13.9j
Patiño Mines and Enterprises, t	Bolivia	4s.	£276,063	....
Total			$46,129,417	

s, silver; l, lead; z, zinc; c, copper; g, gold; n, nickel; h, holding; t, tin; Q, quarterly; SA, semi-annually; M, monthly; X, extra; I, initial; MX, monthly 25c., extra 50c.; MXX, monthly 5c., extra 7c.; BM, bi-monthly; FW, every four weeks; QX, 10c. regular quarterly and 30c. extra; QXX, 50c. regular quarterly and 25c. extra; XX, quarterly $1 extra $2; XXX, quarterly $1.50, extra $1; SAX, semi-annually $0.75, extra $1.25; j based on dividends for past twelve months.

London Financial News

By W. A. Doman
Special London Correspondent

London, Dec. 11, 1928—Affairs in the mining world are now assuming a livelier aspect. In the first place the tin producers are not going to accept present prices without a battle; they are out for stabilization, if possible, and when the few large companies—there are only a few—can get together, something definite may eventuate. The Far East is not holding up the metal; it is too great a financial strain, and demand is overtaking supply. So far as the experts can see, no country other than those already producing tin is likely to contain commercial deposits. Consequently the future is looked forward to with every confidence.

When Leslie Urquhart, mining engineer and financier, brings any proposition forward, it is a big affair. Though his Russo-Asiatic Consolidated has not yet come to fruition, the failure cannot be laid at his door. The Soviet, with its dog-in-the-manger policy, is the obstacle. The properties are said to have the elements of success, but without capital and expert management they are useless. Having lost £250,000 in the company himself, it is unnecessary to ask how Leslie Urquhart regards the situation. Blocked in the direction of Russia, he turned his attention to Villemagne, in France, and is making a success of the silver-lead property there. When the Anglo-American Corporation abandoned its option on the Mount Isa property, in Queensland, Leslie Urquhart acquired it and is turning it to good account. The original estimate of profit of £850,000 per annum is now believed to err considerably on the conservative side. The first unit of plant, to treat 2,000 tons of ore daily, should be completed by the end of 1929, and production should start early in the next year. Meantime the financier seems to have gone one better, for he has acquired gold-mining concessions in New Guinea. These are on the Edie plateau and cover some eight square miles. As a preliminary, he has formed the Ellyou Goldfields Development Corporation, with a capital of £300,000 in 5s. shares. What is expected of the property, in view of the high assays reported, may be gathered from the fact that it is intended later to form an operating company with a capital of something like £3,000,000. The field is about 32 miles from the port of Salamoa as the crow flies, but highways and a railroad will extend 120 miles.

Further particulars of the new Rhodesian finance company, to which I referred last week, are now available. The title is the Rhodesian Anglo-American, Ltd., and the directors are: Sir Ernest Oppenheimer (chairman), Sir Edmund Davis, Sir Henry Birchenough, Bt., S. B. Joel, J. S. Wetzlar, Carl R. Davis, Major L. A. Pollak, F. Searles, and Walter McDermott. F. Searles represents United States interests. These names indicate that the sponsors of the company include the Anglo-American Corporation, Consolidated Mines Selection, Rand Selection Corporation, Sir Edmund Davis group, British South Africa Company, and the Wankie Colliery Company.

The Rhodesian Selection Trust has come before the public with a capital of £500,000 in 5s. shares. The company acquires the rights and interests of Selection Trust under an agreement between the Trust and Bwana M'Kubwa Copper Company for prospecting rights in the N'Kana Concession, Northern Rhodesia.

It is stated in Paris that the provisional contract between the copper mines of San Platon and the Rio Tinto Company, by which the latter took from the former 40,000 tons of copper pyrites between April and December of this year, has just been made definite and extended for three years, Rio Tinto taking the whole of the production of the San Platon mines.

Aikmans state that judging from the large sales of nitrate in European consuming markets, a record consumption appears assured. Actual figures are not available. There is a possibility that prices of synthetic will be raised.

Survey of World Zinc Conditions

By International Metal Service, London
Foreign Correspondent of American Zinc Institute, New York

THE marked change for the better which has come over the European zinc market since our last month's notes is pleasing to chronicle. Optimism as to a successful outcome of the negotiations for an international agreement or understanding between producers has been instrumental in reviving sentiment and re-creating that measure of confidence which has been so sadly wanting all year.

Speculators had been so long absent from the zinc market that their reappearance as buyers, coupled with a general reluctance among smelters to sell freely, conspired to make this section of the London Metal Exchange particularly active in November. The month's turnover totaled 24,150 tons, the increased business being mainly in the last ten days of November. The effect was to lift the quotation from £23 16s. 3d. on Nov. 1, to £26 7s. 6d. on Nov. 30, with a corresponding gain of £2 7s. 6d. per ton in the forward position. Probably this advance in the selling price has fully discounted the effect of any international agreement, for the time being at any rate. Consequently, we are inclined to expect the market to come back a bit and maybe to fluctuate either side of £26. That indeed was the price idea of sponsors of the cartel at its birth, and we have no reason to believe that their views have undergone any change. Assuming that the selling quotation was stabilized at that figure for a period during which the world zinc industry could be rationalized by the moderate output curtailment necessary, then the way would be paved for stability at a higher price level.

A £26 selling quotation for two or three months would be greatly welcomed by the majority of small producers as a precursor to better things. In only one month this year has zinc averaged over £26. That was in January. The next five months averaged only £25 9s. 8d., and during the following five months the average price was no better than £24 12s. 6d. We estimate the mean average of G.O.B. zinc in London for the year 1928 at £25 4s. 3d., as against an average price in 1927 of £28 9s. 11d. and in 1926 of £34 2s. 0d.

Anyhow, the more favorable conditions for producers have come at an opportune moment, and the industry is able to look forward to the new year with a greater degree of confidence than prevailed a year ago.

We estimate world stocks of zinc on Dec. 1, 1928, as follows:

	Metric Tons
United States	42,200
Canada, including afloat	4,500
Germany-Poland	5,800
Belgium	6,000
France	600
Great Britain	1,500
Other Europe	1,000
Australia, including afloat	6,600
Far East	800
Elsewhere	2,000
Total	71,000

Alaskan Gold Production Increases

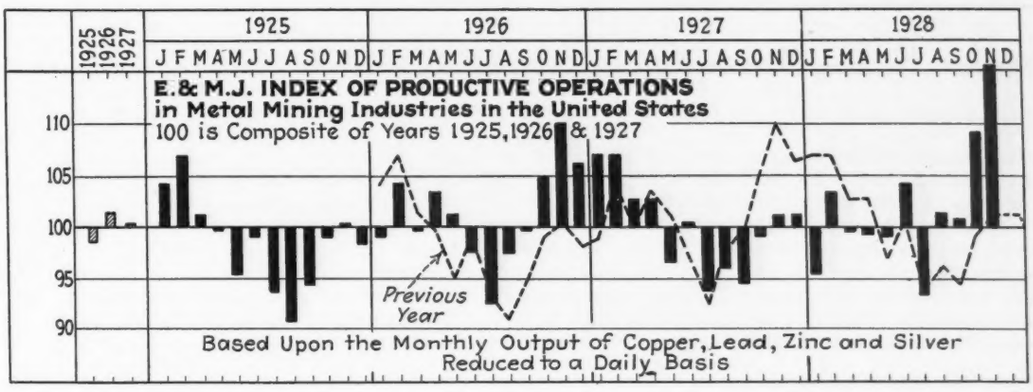
The annual message of George A. Parks, Governor of Alaska, places the mineral production of Alaska since 1880 at $585,374,000, of which about 62 per cent has been in gold. The record output was $48,386,580 in 1916. Gold production of Nome for this year will be about $1,250,000, about $80,000 below 1927. The gold output of Fairbanks this year is estimated at around $1,000,000, almost entirely from the dredges of the Fairbanks Exploration Company.

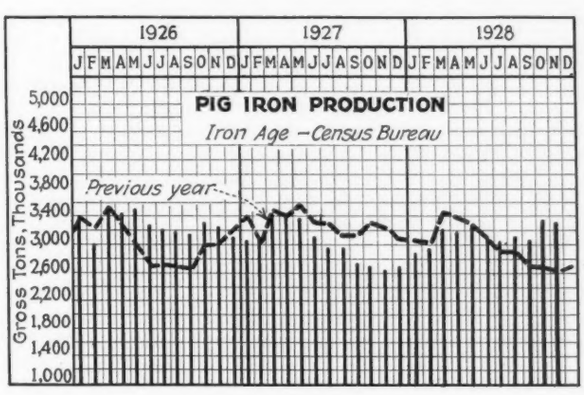
Market Exists for Domestic Iron Oxides

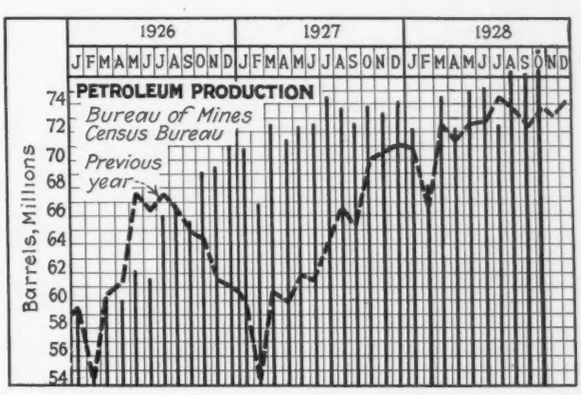
Iron oxides for pigments are wanted by C. K. Williams & Company, paint manufacturers, Shellmound Park, Emeryville, Calif. The company recently completed a half million dollar plant at Shellmound Park, and will try to find and develop deposits of suitable material in the West near its new factory. Samples will be analyzed free if sent to Verne Frazee, the manager of the company, at Emeryville. Reds, browns, and yellows—particularly the latter—are sought. Deposits should be free of impurities, especially sulphur. Most of the iron oxide consumed in paint manufacture in America is shipped in from Europe.

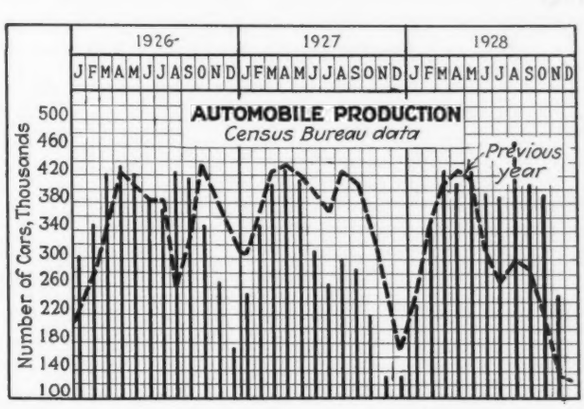
Indicators of Industrial Activity

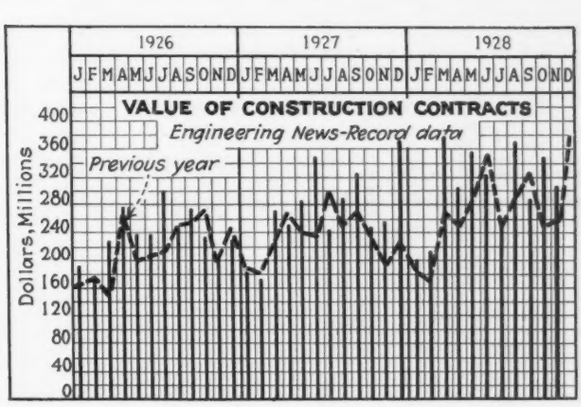
of Significance to Mining

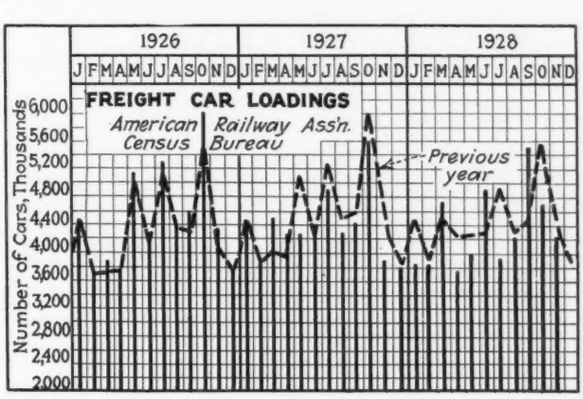


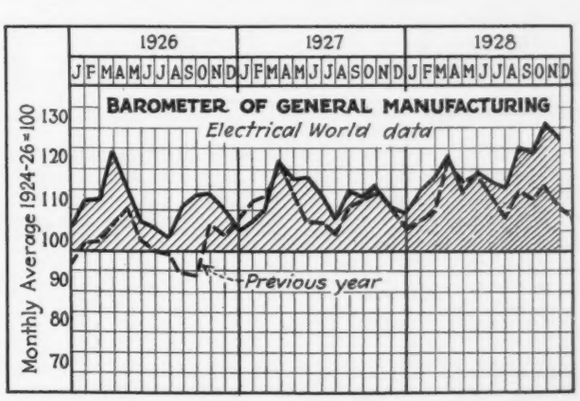












The Market Report

Copper Sales Break Record Again

Spectacular Domestic Buying Results in Further Price Advance

New York, Dec. 26, 1928—The behavior of the copper market during 1928 has induced the use of many superlative descriptive terms, but in none of its various phases has the situation been more astounding than during the last *E.&M.J.* week, covering the holiday period. Following several weeks of inactivity, the copper market came to life late last Wednesday afternoon. Featured by active buying on the part of one or two of the leading consumers, the desire for copper became contagious, and all buyers quickly decided that they could use a little more copper also, resulting in a new sales record and an advance in price of a quarter of a cent. Except for the activity in copper, the non-ferrous metal markets have been very quiet, though there has been no indication of price weakness.

Daily Prices of Metals

Dec.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
20	15.775	49.50	6.50	6.35	6.35
21	15.775	49.25	6.50	6.35	6.35
22	15.775	49.375	6.50	6.35	6.35
24	15.80	49.75	6.50	6.35	6.35
25	Holiday	.....	....	....	....
26	16.025	49.875	6.50	6.325@6.35	6.35
	15.830	49.550	6.500	6.348	6.350

Average prices for calendar week ending Dec. 22, 1928, are: Copper, 15.775; Straits tin, 49.458; N. Y. lead, 6.500; St. Louis lead, 6.350; zinc, 6.344; and silver, 57.229.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
20	69 9/16	69	74 3/4	223 5/8	222 7/8	21 5/16	21 11/16	26 11/16	26 1/2
21	70 5/16	69 1/2	74 3/4	222 7/8	223	21 1/8	21 9/16	26 3/4	26 9/16
24	70 3/8	69 9/16	74 3/4	224	223 3/4	21 3/16	21 9/16	26 11/16	26 1/2
25	Holiday	....	...	....	....	....	....	....	....
26	Holiday	....	...	....	....	....	....	....	....

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
20	4.85	57 1/4	26 5/16	84s11½d	24	4.84 5/8	57 5/8	26 7/16	84s11½d
21	4.84 7/8	57 1/8	26 3/16	84s11½d	25	Holiday	...	....	.....
22	4.84 5/8	57 3/8	26 5/8	.....	26	4.84 3/4	57 1/2	Holiday	Holiday

Ave. 57.375

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-quarters cent premium.

Copper at 16¼c. Following Tremendous Buying Activity

The various factors in the copper industry that had predicted a long period of inactive demand following the heavy autumn buying find an entirely different situation facing them today, for, despite the presence of the Christmas holidays in the week ending today, sales of copper to domestic consumers total several thousand tons in excess of the previous weekly record established early in September. Apparently the re-entry of several of the largest consuming interests in the trade served as the spark which started the conflagration, though a distinct improvement in buying on foreign account has been a significant factor. When consideration is given to the holidays and half-holidays during the past week, the distribution of sales per business day exceeds 13,500 tons and the explanation for today's advance in price to 16¼c. is readily discernible. No sales at the higher price were made until today, although several producers withdrew from the market at the lower figure on Monday. A large proportion of the sales has been for March delivery—in several instances April has been specified; so the tendency for forward buying has been decidedly marked. Copper Exporters, Inc., maintain their price at 16¼c. c.i.f. usual European destinations, though it is expected that announcement of an advance in price to conform with the usual ¼c. differential over the domestic price will be made tomorrow. The leading brass company announced an increase in price of its various copper and brass products today.

Lead Market Dull and Unchanged

Little interest was exhibited in lead during the week ending today, and the average daily volume of sales was even less than last week. The London price declined slightly, and as it was already near import parity for bullion, consumers evidently thought that if there were to be any price change in this country it would be more likely to be down than up, and so withheld their orders. Domestic producers, however, are in no rush to sell, having already disposed of most if not all of their production for the next two months. They feel that if it were not for the quietness abroad there would have been a very real strengthening of prices here. The lack of any active consuming demand abroad seems to be the only weak feature in the lead market at present. Buying there has been less than expected for several months.

The indications are that consuming demand in the United States will improve in 1929. Battery and cable manufacturers are particularly optimistic. It is probable that less lead has been used for paint in 1928 than in 1927, but here, too, better conditions are expected for the coming year.

Producers' prices are uniformly 6½c., New York, and 6.35c., St. Louis, though it is quite possible that a 2½-point concession could be obtained on chemical lead through dealers in the Middle West, and some scattering business may thus have been placed at 6.325c., St. Louis.

Zinc Continues Quiet; Prices Firm

Slab-zinc business during the last week has been very light. Galvanizers appear to consider themselves fortunate to have covered their first-quarter requirements so thoroughly without more of a price advance than was actually effected by producers. Much of the business done in the last week has been for prompt shipment, indicating that consumers are merely rounding out their requirements based on current orders from the trade.

Tin Continues Firm at Close to 50c.

Though demand has not been great, and production is more than equal to it, the tin market continues as firm as ever, and is apparently not being allowed to slip much below £225 in London, which means close to 50c. here. The support of the Anglo-Oriental group abroad is reflected in the increase in the warehouse stocks of tin in London from 1,500 long tons last July to over 7,000 long tons now. It thus seems possible that this support of the market may continue during the period of high production, which some people expect to reach a peak in 1929, and that the accumulated tin may not be released until consumptive demand overtakes production. If things work out that way, present levels of tin prices may be well maintained. Prices of forward tin are substantially the same as for prompt Straits. The 99 per cent grade is nominal, with but little arriving in this country.

Foreign Exchanges Firm

Foreign exchanges have been generally firm. Closing cable quotations on Monday, Dec. 24, were as follows: Francs, 3.91⅝c.; lire, 5.24c.; and marks, 23.84c. Canadian dollars, ¼ of 1 per cent discount.

Silver Higher and Steady

The silver market continued quiet until Dec. 22, when higher rates from China improved the tone considerably. Good buying orders from this quarter resulted in a rise in quotations, and the metal closes steady today at 57½c.

Mexican Dollars (Old Mexican pesos): Dec. 20th, 43⅛c.; 21st, 43c.; 22d. 43¼c.; 24th, 43⅛c.; 25th, holiday; 26th, 43⅜c.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 9⅝@9¾c. per lb. for spot; 9¾@9⅞c. per lb. for futures. Cookson's "C" grade, spot, 15⅜c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM — Per lb., New York: 85@95c. Active demand.

IRIDIUM—Per oz., $275 for 98@99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $42@$44. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $74.

QUICKSILVER — Per 76-lb. flask. $122@$123, cash. Small lots command the usual premiums. Market quiet.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Dec. 8.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $11.75@$12; Western scheelite, $12.

Chrome, Iron, Manganese, Tantalum, Titanium, and Vanadium ores are unchanged from quotations in the Dec. 8 issue.

Some Selling Agency Contracts Signed

Joplin, Mo., Dec. 22, 1928

Blende	Per Ton
High	$43.10
Premium, blende, basis 60 per cent zinc	$40.00@ 41.00
Prime Western, basis 60 per cent zinc	39.00@ 40.00
Fines and slimes, 60 per cent zinc	36.00@ 38.00
Average settling price, all zinc	39.62

Galena	
High 80 per cent lead	$86.80
Basis 80 per cent lead	85.00
Average settling price, all lead	85.31

Shipments for the week: Blende, 14,867; lead, 1,677 tons. Value, all ores the week, $732,150.

A representative of the selling agency proposed last summer was in the district during the past fortnight, and it is reported that some signatures were secured, though definite information will not be disclosed by any of the interested parties. The representative has returned to his headquarters in the East.

Shipments continue to exceed the production, and with this week's shipment all the most desirable ore will have been removed from the Oklahoma part of the district. Producers over the line in Kansas have three months before tax assessment date in that state and were not anxious to accept offerings this week.

A majority of producers continue to sell current output of lead, but bin stocks are being reserved in expectation of a higher market after the end of the year.

Platteville, Wis., Dec. 22, 1928

Zinc Blende	per Ton
Blende, basis 60 per cent	$42.75

Lead Ore	
Lead, basis 80 per cent	$85.00

Shipments for the week: Blende, 876 tons; lead, 80 tons. Shipments for the year: Blende, 37,207 tons; lead, 1,850 tons. Shipments for the week to separating plants, 1,077 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Dec. 8 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Market fairly active.

Antimony Oxide, Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Dec. 8 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $33@$34 f.o.b. furnace.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrovanadium and Monel metal are unchanged from prices in the Dec. 8 issue.

NICKEL SILVER — Price for 18 per cent Grade A sheets advanced from 31 to 31¼c. per lb., effective Dec. 26.

YELLOW (MUNTZ) METAL—Price for dimension sheets advanced from 21½ to 21¾c. per lb.; for rods, advanced to 18¾c. from 18½c. per lb.; effective Dec. 26.

Rolled Metals

COPPER—Price for sheets, hot rolled, advanced from 25 to 25⅜c. per lb. on Dec. 26; for wire advanced from 17⅞ to 18⅛c. per lb. Dec. 24.

Lead and Zinc Sheets are unchanged from prices in the Dec. 8 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Dec. 8.

Iron, Steel, and Coke

Iron—Per gross ton, Valley furnaces. Bessemer, $18.25@$18.50; basic, $17.50 @$18; No. 2 foundry, $18.

Steel—Base prices per gross ton, Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per lb., 1.90@2c.

Coke—Per gross ton, Connellsville furnace, $2.75. Connellsville foundry, $3.75@$4.85. By-product coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended December 22, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	114⅛	102⅛	114⅛	Oc.13, No. 19 Q	1.00
Andes Copper	New York	51	45½	50⅝	No. 15, De. 17 I	0.75
Aris. Com'l	Boston	4⅛	4⅛	4⅛	Jl. 16, Jl. 31 SA	0.25
Cal. & Ariz.	New York	121⅛	109½	119⅛	De. 1. De. 17 QX	2.50
Calumet & Hecla	Boston	42⅛	39½	41⅛	No 30, De.15,Q	1.00
Cerro de Pasco	New York	108⅛	98⅛	107⅛	Oc.11, No. 1 Q	1.25
Chile Copper	New York	69⅛	61	69⅝	De.5 . De.29 Q	0.75
Con. Coppermines	N. Y. Curb	14½	13⅛	13⅝	.....	.....
Copper Range	Boston	26½	24½	25½	De. 15, Ja. 15 Q	0.50
Crystal Copper	Boston Curb	*35	*29	*33	.....	.....
East Butte	Boston	3⅜	3½	3⅜	Dec., 1919	0.50
Granby Consol	New York	93	82	88⅛	Ja.4, Fe.1 Q	1.50
Greene Cananea	New York	177	161⅛	175	De.1 , Ja.7 Q	1.50
Howe Sound	New York	68	62½	62½	De.31, Ja.5, Q	1.00
Inspiration Consol	New York	43	40⅛	42½	De. 20, Ja. 7 Q	0.75
Isle Royale	Boston	25	23	24½	De.5, De.15 Q	0.50
Kennecott	New York	147⅛	130⅛	147⅛	No.30, Ja 2 Q	2.00
Magma Copper	New York	69⅛	61	66	De.31, Ja.15 Q	1.00
Mason Valley	N. Y. Curb	2	1⅞	2	.....	.....
Miami Copper	New York	29⅛	27⅛	29⅛	No.1, No.15, Q	0.37½
Mohawk	Boston	47	43	47	Oc. 31, De. 1 Q	3.00
Montana-Idaho	Spokane	*11⅞	*10⅛	*10½	.....	.....
Mother Lode Coal	New York	3⅛	3⅛	3⅛	De.14, De. 31,	0.20
Nevada Consol	New York	35⅛	32⅛	35⅛	De.14, De.31 Q	0.50
New Cornelia	Boston	41¼	39	39	No.2, No.19 Q	0.50
Noranda	N. Y. Curb	65⅛	56⅛	63	.....	.....
North Butte	Boston	6⅛	5⅛	6⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	1⅛	1⅛	1⅛	Sept., 1926	0.03
Old Dominion	Boston	18⅛	16⅛	17⅞	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	....	....	189⅛	De.18, Ja.2 Q	2.50
Quincy	Boston	44	36	41⅛	March, 1920	1.00
St. Mary's Min. Ld	Boston	34⅜	33⅛	34⅛	No.20, De.1	1.00
Seneca Copper	New York	6⅛	5	5⅛	.....	.....
Shattuck-Denn	N. Y. Curb	22	18⅛	20⅛	.....	.....
Tenn. C. & C.	New York.	18⅛	16⅞	18⅛	Au., 31 Se.15,Q	0.25
United Verde Ex	N. Y. Curb	25	22⅛	23⅞	Ja.4, Fe.1	0.75
Utah Copper	New York	255	235	255	De.14, De.31 Q	3.00
Utah Metal & T	Boston	1⅛	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	2.50	2.00	2.35	.....	.....
NICKEL-COPPER						
Internat. Nickel	New York	269	239	262½	De.13, De.31 Q	0.75
Internat. Nickel pfd.	New York	....	....	118½	Oc.1, No.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*5	*5	*5	June, 1927	0.005
National Lead	New York	124½	120½	123	De.14, De.31 Q	1.25
National Lead, pfd. A	New York	141⅜	140	140	No.3, De.15 Q	1.75
National Lead, pfd. B	New York	119	119	119	Ja. 18, Fe.1 Q	1.50
St. Joseph Lead	New York	55⅛	52⅞	52⅞	Ma.8, Ma.20 QX	0.75
ZINC						
Am. Z. L. & S.	New York	43	32⅛	41⅜	May, 1917	1.00
Am. Z. L. & S. pfd.	New York	106	94	104⅜	Nov., 1920	1.50
Butte C. & Z	New York	9	8⅛	8⅛	De.14, De.31 Q	0.50
Butte & Superior	New York	10	9⅛	9⅛	Se.14, Se.29 Q	0.50
Callahan Zn-Ld	New York	3⅛	3	3⅛	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	11	11	11	Je.25, Jl.1 Q	0.25
Eagle-Picher	Cincinnati	19⅜	19	19⅛	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati	....	....	110	July 15 Q	1.50
Evans-Wallower	N. Y. Curb	16	12⅛	16	.....	.....
New Jersey Zn	N. Y. Curb	259⅛	248	259⅛	No. 20, De. 10 X	2.00
Treadwell-Yukon	Toronto	9.75	9.50	9.75	.....	.....
United Zinc	N. Y. Curb	....	....	1⅜	.....	.....
Yellow Pine	Los Angeles	....	....	*23	Dec., 1925 QX	0.04
GOLD						
Alaska Juneau	New York	8⅜	7⅛	8⅛	.....	.....
Barry-Hollinger	Toronto	*34	*28	*30	.....	.....
Central Manitoba	Toronto	....	....	*78	.....	.....
Coniaurium	Toronto	....	....	1.00	.....	.....
Cresson Consol. G	N. Y. Curb	*79	*73	*74	Oct. 15, Q	0.02
Dome Mines	New York	9⅛	9	9⅛	De.21, Ja.21 Q	0.25
Gold Hill	Toronto	....	....	*7½	.....	.....
Golden Cycle	Colo.Springs	†1.56	†1.54	....	No. 30, De.10 Q	0.04
Hollinger Consol	Toronto	8.40	8.10	8.10	De 12, De. 31 M	0.05
Homestake Mining	New York	76	76	76	De.20, De.26 M	0.50
Kirkland Lake	Toronto	1.30	1.26	1.30	.....	.....
Lake Shore	Toronto	17.65	16.50	17.25	De.1, De.15 QX	0.40
McIntyre Porcupine	New York	20	19⅛	19⅛	No.1, De.1 Q	0.25
Portland	Colo.Springs	†*9	†*7½	....	Ap., 1927	0.02
Rand Mines	New York	37⅛	37⅛	37⅛	Au.21-28 Am.Sh	1.52
Sylvanite	Toronto	2.00	2.00	2.00	.....	.....
Teck-Hughes	Toronto	8.40	7.50	8.20	Oc.17, No.1	0.15
Tom Reed	Los Angeles	....	....	*25	Dec., 1926	0.02
Vipond Cons	Toronto	*72	*65	*71	April, 1927	0.03
Wright-Hargreaves	Toronto	1.55	1.50	1.52	Oc.16, No.1 Q	0.02½
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	21⅛	19⅜	19⅜	.....	.....
Con. Cortez	N. Y. Curb	....	....	*20	.....	.....
Dolores Esperanza	N. Y. Curb	*81	*81	*81	July, 1923	0.05
N.Y. Hond'a Rosario	N. Y. Curb	16⅛	16⅛	16⅛	De.15, De.24 X	0.25
Premier Gold	N. Y. Curb	2⅛	2⅛	2⅛	De.14, Ja.4	0.06
Tonopah Belmont	N. Y. Curb	....	....	*61	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*8	*6	*6	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	3⅛	3⅛	3⅛	Se.29,Oc.20 SA	0.07½
West End Consol	N. Y. Curb	...	...	*3	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	1	*81	1	June, 1918	0.02
SILVER						
Castle-Trethewey	Toronto	*39	*36	*36	.....	.....
Keeley	Toronto	*40	*40	*40	Mr.1, Mr.15 SA	0.04
Mining Corp. Can	Toronto	3.75	3.55	3.70	De.6, De.20 SA	0.1½
Nipissing	N. Y. Curb	3⅜	3⅜	3⅜	De.21, Ja.21 Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	3⅜	3⅜	3⅜	Ap., 1927	0.12
Bingham Mines	Boston	47¼	46½	46½	De.20, Ja. 5 Q	0.50
Bunker Hill & Sullivan	N. Y. Curb	....	....	128½	Oc. 31,No. 5 X	0.75
Cardiff M. & M.	Salt Lake	*36	*34	*36	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	3.45	3.45	3.45	Ja.10, Fe.1 K	0.10
Consti'n Mng.&Mill'g.	Spokane	*35	*35	*35	.....	.....
Erupcion	Boston Curb	*25	*25	*25	Ja. 1, 1928 Q	0.07½
Eureka Lily	Salt Lake	1.30	1.12½	1.17½	.....	.....
Federal M. & S.	New York	215	215	215	Je., 1927	10.00
Federal M. & S. pfd.	New York	99	99	99	No. 23, De. 15 Q	1.75
Golconda	Spokane	*85	*78½	*85	.....	.....
Hecla Mining	N. Y. Curb	16⅛	15⅞	16	No.13, De.14 Q	0.15
Highland-Surprise	Spokane	*13	*12	*13	.....	.....
Iron King Mining	Salt Lake	*83	*83	*83	.....	.....
Keystone Mining	Salt Lake	*25	*25	*25	Fe., 1926	0.07½
Lucky Jim	Spokane	*23½	*21	*21	.....	.....
Lucky Tiger-Com	Kansas City	†6.75	†6.50	...	De.4, De.20 MX	0.87
Mammoth Mining	Salt Lake	†*85	†*66	....	De., 1926	0.25
North Lily	Salt Lake	8.00	7.95	8.00	Oct., 20 I	0.20
Park Utah	New York	10¾	10¼	10¾	De.31, Ja.2 Q	0.20
Plutus Mining	Salt Lake	†2.00	†2.00	....	Ap.10, Ap.16 K	0.10
Rico-Argentine	Salt Lake	*46½	*45	*45	No. 30, De.15 Q	0.03
Sherman Lead	Spokane	*24½	*22	*22	.....	.....
Silver King Coal	Salt Lake	12.87½	12.87½	12.87½	De.15, Ja.2 QX	0.35
Silversmith	Spokane	*8	*8	*8	Oct., 1926 Q	0.02
Strattons Mines	Spokane	1.66	1.50	1.65	.....	.....
Sunshine M. Co.	Spokane	1.25	1.20	1.20	De. 20, B.M.	0.02
Tamarack-Custer	Spokane	*37½	*34	*35	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.37½	13.00	13.00	De23, Ja.23 X	0.20
Utah-Apex	Boston	4⅛	4	4	Jl.14, Au.1 K	0.25
IRON						
Bethlehem Steel	New York	85⅛	78½	82⅞	Jl., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	135	130	130	Oc.15, Oc.25. Q	1.00
Colorado F & I, pfd.	New York	130	130	130	Au.10, Au.25 Q	2.00
Gt. North'n Iron Ore	New York	26½	25½	25½	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	78	72	77	No. 15, De.1 Q	0.62½
Republic I. & S.	New York	80⅜	75	80⅜	No. 14, De. 1 Q	1.00
Republic I. & S. pfd.	New York	108¾	108¾	108¾	De. 10, De. 20 Q	1.50
Sloss-Sheffield S. & I.	New York	115	111	115	De.20, Ja.2 Q	1.75
Sloss-Snef. S.&I. pfd.	New York	....	....	108	Se. 20, Oc. 1 Q	1.75
U. S. Steel	New York	158	149⅜	1566	No.30, De.29 Q	1.75
U. S. Steel, pfd.	New York	141⅛	141	141⅛	No. 3, No.28 Q	1.75
Virginia I. C. & C.	New York	....	....	25½	Jan., 1924	1.50
Virginia I.C.&C. pfd.	New York	....	....	50⅛	Je. 16, Jl. 2 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	...	...	21	Ju.16, Ju.26 K	0.97
So. Am. G. & P.	N. Y. Curb	3¼	3⅛	3¼	.....	.....
Alum. Co. of Amer.	N. Y. Curb	152	148⅜	152	.....	.....
Alum. Co. of Amer. pf.	N. Y. Curb	105	104½	105	De. 15, Ja. 1 Q	1.50
Vanadium Corp.	New York	95⅜	87	93	De.1,De. 15 QX	1.75
Patino M. & E.	New York	34⅜	32	34¼	Aug., 1928	4s.
ASBESTOS						
Asbestos Corp.	Montreal	19⅛	17	17½	Jan., 1926	1.50
Asbestos Corp. pfd.	Montreal	71	66	70	De.31, Ja 15 Q	1.75
SULPHUR						
Freeport Texas	New York	52⅞	46	48	Ja.15, Fe.1 Q	1.00
Texas Gulf	New York	75½	71⅛	73⅞	De. 1, De 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	57⅛	53⅜	57⅛	No. 20, De 1 Q	0.75
Amer. Metal, pfd. 6%	New York	115	115	115	No.20, De.1 Q	1.50
Amer. Sm. & Ref.	New York	273	257	270⅜	Oc. 11, No.1 Q	2.00
Amer. Sm. & Ref. pfd.	New York	138	138	138	No.2, De. 1 Q	1.75
Consol. M. & S.	Montreal	380	342	375	De.31,Ja.15 SAX	6.25
Newmont Mining	N. Y. Curb	204	190	203	De.28, Ja.15 Q	1.00
U. S. Sm. R. & M.	New York	63⅞	60	63	De 31, Ja. 15 Q	0.87½
U.S. Sm. R.&M. pfd.	New York	56	54¼	56	De. 31, Ja.15 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. BM, bymonthly. FW, four weeks. K, irregular. I, Initial. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED December 11, 1928 Last Div.

Name	High	Low	Last	Date	Amount
Alaska Mexican ($5)	20/—	17/6	20/—		
Alaska Treadwell ($25)	70/—	65/—	70/—	Nov., 1926	4 (d)
Aramayo Mines (25 frs.)	70/7½	63/1½	63/9	Nov, 1928	5 p.c. (†)
Burma Corpn. (10 rupees)	15/9	15/—	15/6	Feb., 1929	7 annas*
Bwana M'Kubwa (5s)	12/—	9/6	10/3½		
Camp Bird (2s)	3/9	2/10	3/3	April, 1928	16⅔ p.c.
El Oro (£1)	5/—	4/9	5/—	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	8/9	8/4½	8/9	July, 1928	3¾ p.c.
Mexican Corpn.(£1)	9/6	8/7½	9/—		
Mexico Mines of El Oro (£1)	28/9	23/9	27/6	Dec., 1926	3⅜ p.c.*
Mond Nickel	152/6	138/9	145/—	Aug., 1928	20 p.c.
Mount Isa (£1)	33/9	31/7½	33/9		
N'Changa Copper Mining	30/—	27/6	28/9		
Oroville Dredging (4s)	4/—	2/10½	3/3	Nov., 1928	31½ p.c.
Rhodesian Congo Border (£1)	41/10½	36/10½	41/3		
St. John del Rey (£1)	12/3	11/7½	12/3	Dec, 1928	2½ p.c.
San Francisco Mines (10s)	31/3	30/—	30/3	July 1928	12½ p.c.
Santa Gertrudis (£1)	14/1½	13/9	14/—	July 1928	7½ p.c.
Selukwe (2s. 6d.)	8/—	7/3	7/6	April, 1917	6¾ p.c.
S. Amer. Copper (2s.)	2/1½	1/10½	2/—	Nov., 1917	75 p.c.
Tanganyika (£1)	63/9	58/9	60/—	July 1928	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	11,700	11,235	11,235	July, 1928	182.60 (b)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation.

Turbinair Diamond Drill Aids Underground Prospecting

In this great lead mine

The Sullivan Turbinair Diamond Drill is shown boring a 300-ft. hole at the bottom of a 60-ft. stope. It removes 1⅛-in. core, a continuous, exact sample of the formations cut. It recently drilled 4 holes from an 8x8 drift, 2 upward and 2 downward, at 45 degrees, uncovering new, rich ore deposits to prolong the life of this old mine, which was originally blocked out from the surface many years ago, also by Sullivan Diamond Drills.

Owing to the height of the stope, the light tripod over the drill is necessary, and permits 10 ft. pulls.

In confined workings, the drill columns are braced between the floor and roof.

Cores Preferred to Guesses

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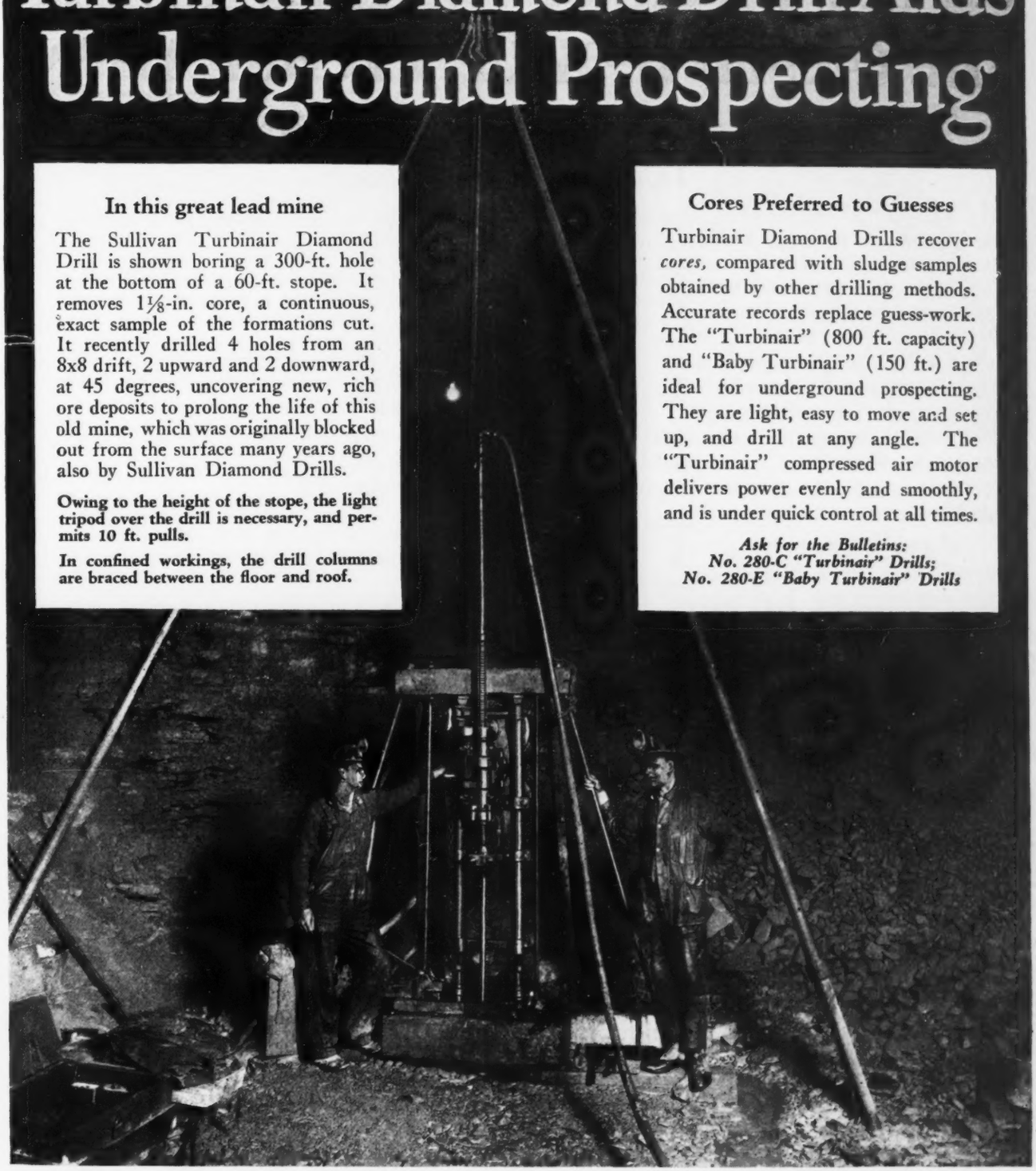
Ask for the Bulletins:
No. 280-C "Turbinair" Drills;
No. 280-E "Baby Turbinair" Drills



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"It is believed generally by competent authorities that the life of most equipment could be extended one month for every year it actually serves.

"Where figures are available, you will find that increased production has followed the adoption of correct lubrication throughout a plant on a standardized plan.

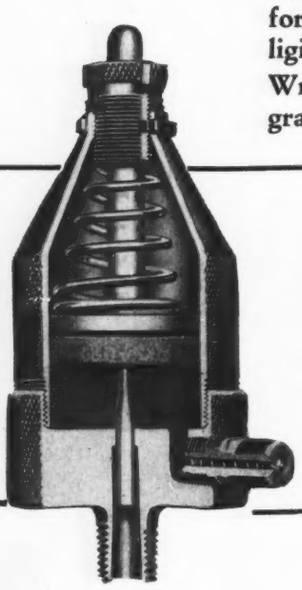
"Don't shy away from this essential result of modern lubrication methods . . . It is the one universal measuring stick, applied in any plant."

THESE are all truths as stated by the Vacuum Oil Company, facts uncovered by exhaustive research; facts that must be faced.

You are acquainted with the Vacuum Oil Company's "Lubrication Audit," which is a complete survey of a plant's particular lubrication requirements. The DOT "Case Study," a survey of the adequate mechanical means for applying lubricant, is comparable to this "Lubrication Audit."

The use of the correct lubricant, handled by DOT Devices, forms a combination that cuts down that "90 per cent" to a negligible factor.

Write for the book, "Better Lubrication for All Machinery"—gratis, of course.



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A self-contained pressure lubricating system that automatically feeds grease to the bearing under a pressure that never varies as long as any grease remains in the cup. One filling lasts 1 to 21 days, depending on the adjustment to bearing needs.

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DOT Group Lubrication System
DOT Electric Lubricator
DOT Little Giant Grease Pump
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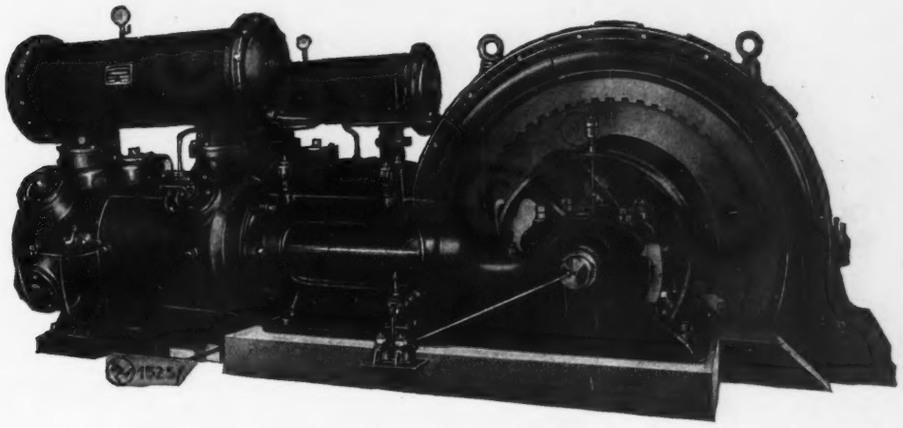
We are manufacturing

Triple Compression-Chamber Compressors



For stationary plants as single and twin cylinder types with forked frame and cross-head guide.

It has been proved that the novel and original load distribution in the driving mechanism, particularly during the dead center position, results in very quiet running and high efficiency.

The Secret of the quiet, smooth running lies in the special method of valve control. This unique feature is protected by Domestic and Foreign Patents.

Therefore the Flottmann is superior to other systems

Please forward us information regarding the

Flottmann

Type Mg Compressors

*Name*_____

*Address*_____

_____

Flottmann

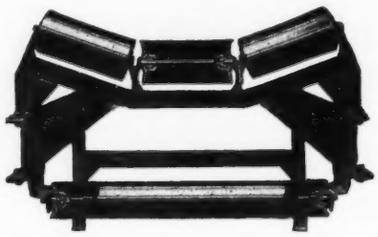
MACHINE WORKS,
Herne, Germany

Does your material come In ter mit tent ly— *or in a Steady Stream* ?

HOW much more convenient it is to have your raw material flow into the plant in a steady stream, rather than intermittently. No congestion is produced, and the rate of movement can be controlled to coincide with the flow of materials through all stages of the manufacturing process. But, best of all, the Link-Belt Conveyor furnishes the *lowest cost* transportation. In one large, modern plant, for instance, haulage by Link-Belt reduced costs to less than 12% of former, highly efficient methods.

You simply cannot afford not to be interested in the many advantages of Link-Belt Belt Conveyors. Write today for Belt Conveyor Data Book No. 615.

Link-Belt Conveying embodies both equipment and service. An indication of what these amount to is given in the Data Book No. 615. Your copy is ready.



LINK-BELT COMPANY 3417

Leading Manufacturers of Elevating, Conveying, and Power Transmission Machinery and Chains

CHICAGO, 300 W. Pershing Road INDIANAPOLIS, 200 S. Belmont Ave. PHILADELPHIA, 2045 W. Hunting Park Ave.

LINK-BELT

ANTI-FRICTION BELT CONVEYOR

Dependability

Standard Mounting Steel Wheels

Class 110...$1650
Class 160...$2450
Class 220...$2800
Class 265...$3200
Class 310...$3500

Above Prices F. O. B. Factory

GARDNER-DENVER Portable Compressors represent the acme of a dependable air supply. The power plant consists of a Gardner-Denver Type XH Vertical Compressor, favorably known for its high efficiency. It is directly connected to a powerful Buda engine. Both are mounted on a one piece cast steel frame, assuring perfect alignment. They are manufactured in five sizes and a variety of mountings.

Complete details are given in our new PORTABLE BULLETIN *which will be mailed you on request.*

GARDNER-DENVER COMPANY

QUINCY, ILL. DENVER, COLO.
Branches in All Principal Cities

G-D Trailer Mounting Rubber Tired Wheels

Class 110...$1875
Class 160...$2800
Class 220...$3190
Class 265...$3800
Class 310...$4100

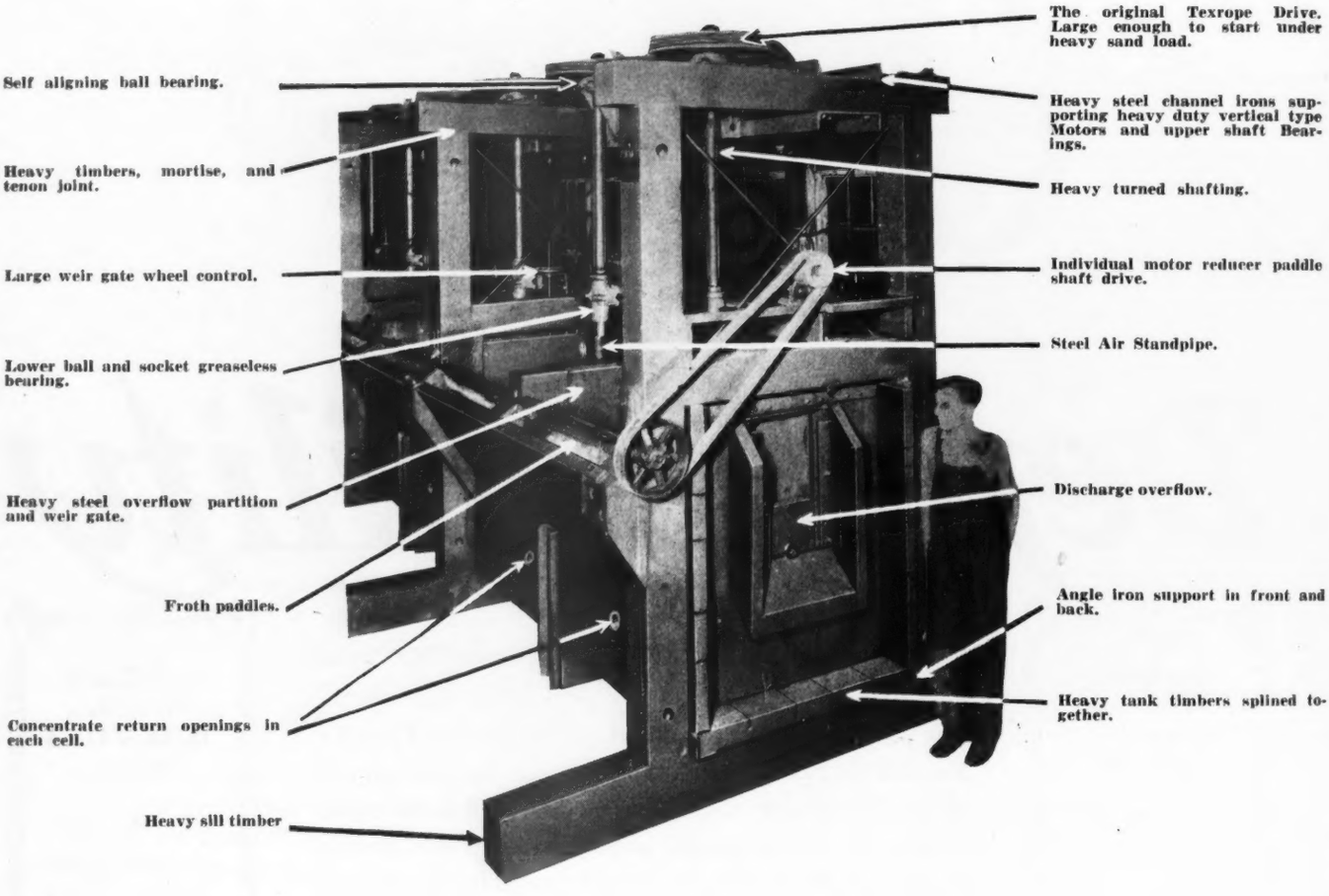
Above Prices F. O. B. Factory

GARDNER-DENVER

FLOTATION ENGINEERS

THE WORLD'S LARGEST IS ALSO THE

Mechanical Reasons


The original Texrope Drive. Large enough to start under heavy sand load.
Self aligning ball bearing.
Heavy steel channel irons supporting heavy duty vertical type Motors and upper shaft Bearings.
Heavy timbers, mortise, and tenon joint.
Heavy turned shafting.
Large weir gate wheel control.
Individual motor reducer paddle shaft drive.
Lower ball and socket greaseless bearing.
Steel Air Standpipe.
Heavy steel overflow partition and weir gate.
Discharge overflow.
Froth paddles.
Angle iron support in front and back.
Concentrate return openings in each cell.
Heavy tank timbers splined together.
Heavy sill timber

Built like a battleship and as simple as A B C. You be the judge—we are showing you the Denver "Sub A" (Fahrenwald) flotation machine, for we know you will appreciate its rugged construction, correct design, simple method of building woodwork, including the tank with the cell partitions bolted in place, and the original and most efficient method of driving the impeller shaft.

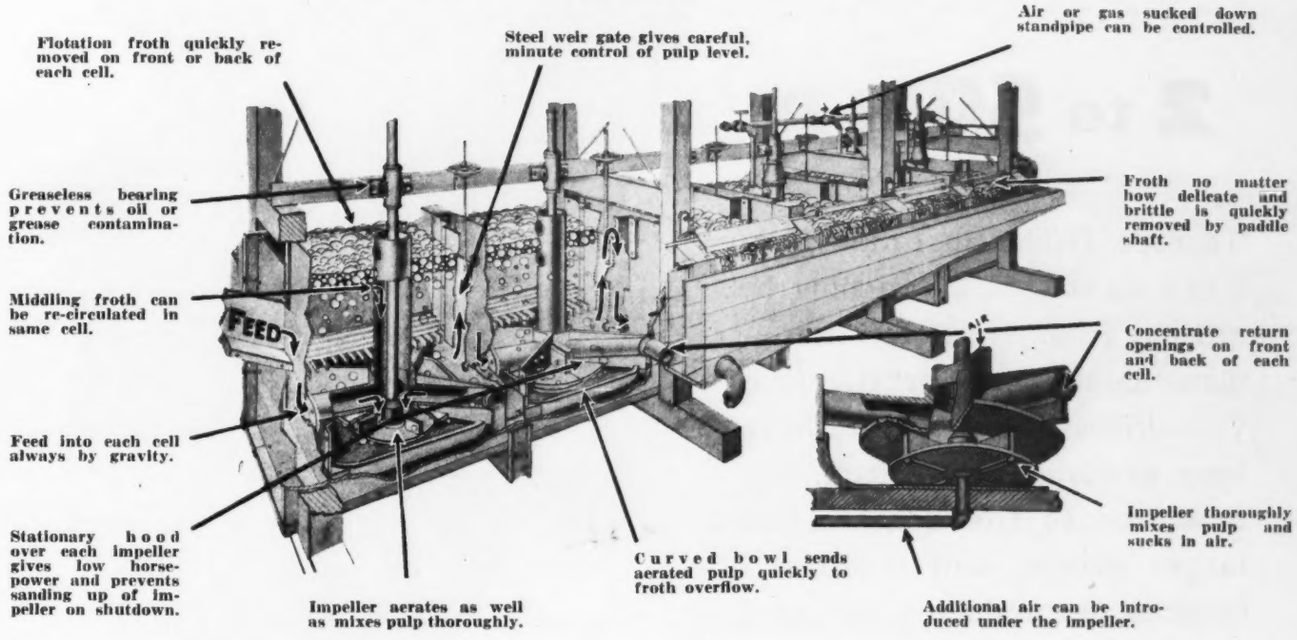
DENVER EQUIPMENT CO.
1419 17th Street — Denver, Colorado.

DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

FLOTATION ENGINEERS

FLOTATION MACHINE WORLD'S BEST

Metallurgical Reasons


Flotation froth quickly removed on front or back of each cell.
Steel weir gate gives careful, minute control of pulp level.
Air or gas sucked down standpipe can be controlled.
Greaseless bearing prevents oil or grease contamination.
Froth no matter how delicate and brittle is quickly removed by paddle shaft.
Middling froth can be re-circulated in same cell.
FEED
AIR
Concentrate return openings on front and back of each cell.
Feed into each cell always by gravity.
Impeller thoroughly mixes pulp and sucks in air.
Stationary hood over each impeller gives low horsepower and prevents sanding up of impeller on shutdown.
Curved bowl sends aerated pulp quickly to froth overflow.
Impeller aerates as well as mixes pulp thoroughly.
Additional air can be introduced under the impeller.

In the Denver "Sub A" (Fahrenwald) flotation machine any cell can be used as a rougher, cleaner, or conditioner. Reagents can be added in each cell to float its particular mineral, the depth of froth varied and air or gas drawn down each standpipe.

Froth can be built up by recirculating rougher concentrate through the concentrate return openings without use of pumps or elevators. You can reclean concentrates by the series cell arrangement, enabling you to treat an extremely low mineral content ore.

Following are some recent users of the Denver "Sub A" (Fahrenwald) Flotation Machine:

Bunker Hill & Sullivan, Cascade, Idaho; Kellogg, Idaho.
Burma Mines Co., Burma, India.
St. Joseph Lead Co., Hughesville, Montana; Mine La Motte, Missouri; Bonne Terre, Missouri.
American Cyanamid Co., Linden, New Jersey.
Calumet & Hecla, Isle Royale Mill, Michigan: Ahmeek Mill, Michigan.
Mohawk Mining Co., Michigan.
Quincy Mining Co., Michigan.
Champion Copper Co., Michigan.
Century Zinc Co., Baxter Springs.
La Plata Mines, La Plata, Colo.
C. M. Lane, Silverton, Colo.

Write for new Flotation Bulletin 2901

DENVER EQUIPMENT CO.
1419 17th Street – Denver, Colorado.

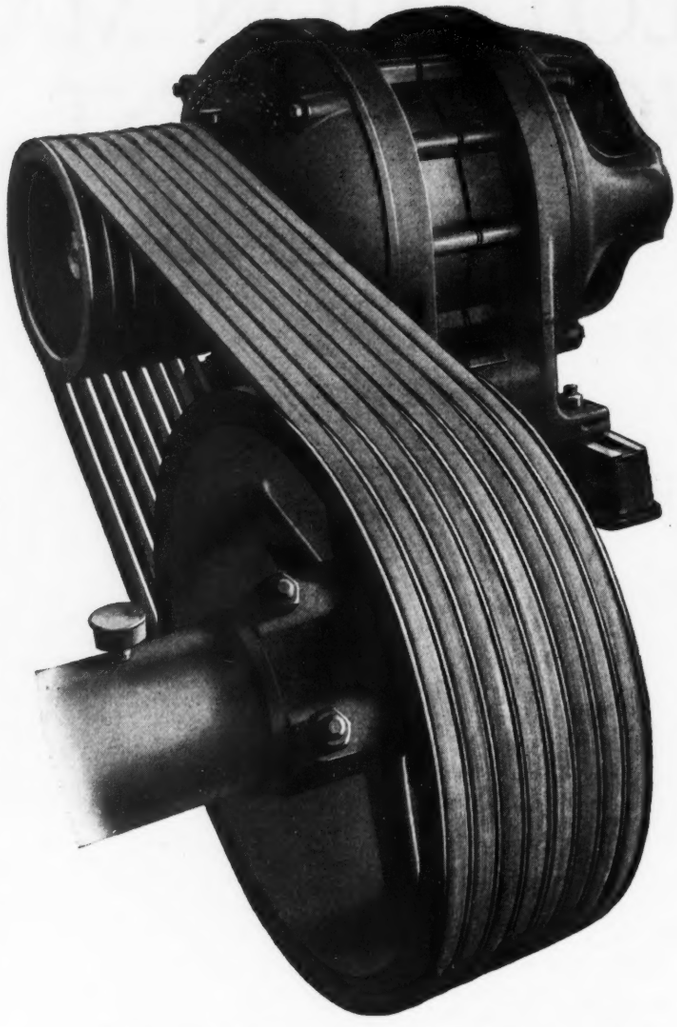
DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

TEXROPE DRIVES

from stock

2 to 50 H.P.

Texrope Drives in ratios from 1 to 1 up to 7 to 1 can now be ordered from stock for immediate shipment. For the past year drives up to 15 H.P. have been available from stock, but now due to the demand for larger drives, and increased facilities for producing standard drives, Allis-Chalmers offers this increased service. The Allis-Chalmers District Offices listed below are for your convenience in ordering Texrope Drives.



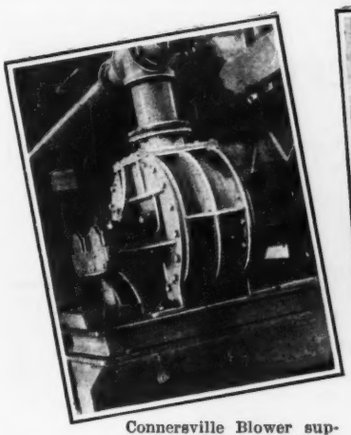
Texrope Drives are the positive and flexible, multiple belt drives for short centers. A complete drive consists of a number of V-shaped rubber and fabric belts operating on V-grooved pulleys. The drive is quiet, smooth running, requires no lubrication, and is not affected by moisture or atmospheric conditions. Texrope Drives are built in sizes from one to 2000 H.P.

DISTRICT SALES OFFICES

ATLANTA, GA.....1104-1110 Healey Bldg.
BALTIMORE, MD. ....1403 Hearst Tower Bldg.
BIRMINGHAM, ALA.....701 Brown-Marx Bldg.
BOSTON, MASS.....723-724 State Mutual Bldg.
BUFFALO, N. Y.....574-576 Ellicott Square Bldg.
CHARLOTTE, N. C.....1118 Johnston Bldg.
CHICAGO, ILL.....1321 Peoples Gas Bldg.
CINCINNATI, O...1720 First National Bank Bldg.
CLEVELAND, O..1724-1725 Guarantee Title Bldg.
DALLAS, TEX.....1515 Santa Fe Bldg.
DENVER, COLO.....525-26-27 Symes Bldg.
DETROIT, MICH.....1109-1112 Ford Bldg.
DULUTH, MINN.....709 Alworth Bldg.
GRAND RAPIDS, MICH..310 Bldg. and Loan Bldg.
HOUSTON, TEX.....1108 Post Dispatch Bldg.
INDIANAPOLIS, IND..1609 Merchants Bank Bldg.
JACKSON, MICH..406 Consumers Power Co. Bldg.
KANSAS CITY MO...1410-1412 Waldheim Bldg.
LOS ANGELES, CALIF.....1117 Rowan Bldg.
MILWAUKEE, WIS.....West Allis Works.
MINNEAPOLIS, MINN.707 Metropolitan Life Bldg.
NEW ORLEANS, LA.....1124 Canal Bank Bldg.
NEW YORK, N. Y.....50 Church Street.
PHILADELPHIA, PA.....711-712 Atlantic Bldg.
PHOENIX, ARIZ.....413-414 Heard Bldg.
PITTSBURGH, PA.....1209 Park Bldg.
PORTLAND, ORE....505-506 Lumbermen's Bldg.
RICHMOND, VA.....905 Electric Bldg.
ST. LOUIS, MO.....2188 Railway Exchange Bldg.
SALT LAKE CITY, UT.....915-916 Kearns Bldg.
SAN ANTONIO, TEX..619 Frost Nat'l Bank Bldg.
SAN FRANCISCO, CALIF...741-751 Rialto Bldg.
SEATTLE, WASH.....115 Jackson Street.
TAMPA, FLA.....415 Hampton Ave.
TOLETO, O.....819 Ohio Bldg.
WILKES-BARRE, PA...917 Coal Exchange Bldg.

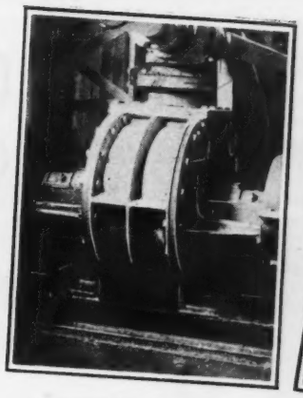
ALLIS-CHALMERS

MILWAUKEE, WIS. U.S.A.

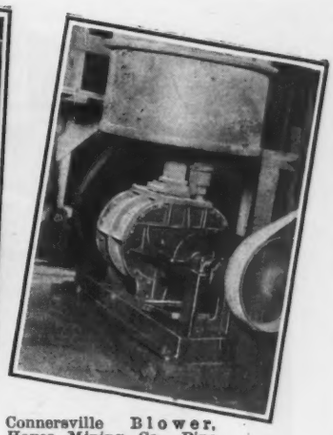


Connersville Blower supplying air for primary flotation cells in 500 ton mill, Calaveras Copper Co., Copperopolis, Cal.

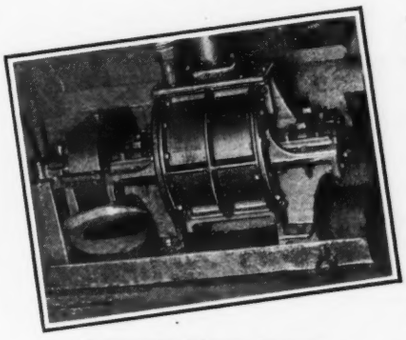
Bunker Hill Smelter, Kellog, Idaho.



Connersville Blower supplying air for cleaning and re-treatment callow cells in 500 ton mill, Calaveras Copper Co.



Connersville Blower, Hayes Mining Co., Pine Creek, Kellog, Idaho.



Connersville Blower, Sweeney Mill, Bunker Hill & Sullivan Co., Kellog, Idaho

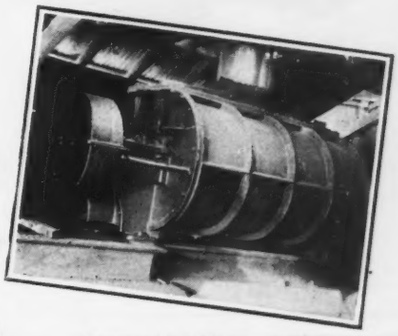
Flotation— Smelting or Matte Furnace

In each, the dependable supply of a definite volume of air is important if satisfactory results are to be obtained.

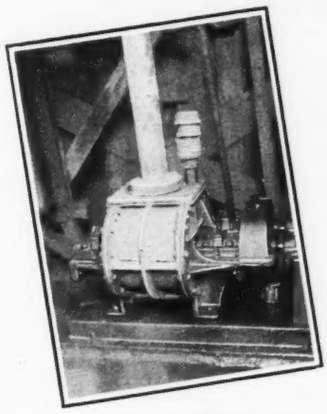
Connersville Rotary Positive Blowers with their inherent characteristics of displacing a known volume each revolution, force the necessary air to the porous bottom or to the tuyeres.

Dependable service is assured by the design of gears, of bearings, of correct proportioning of parts to load stresses, all based on the fundamental principle of this company—"to produce the best blowers on the basis of operating efficiencies, low power consumption and a minimum of maintenance expense."

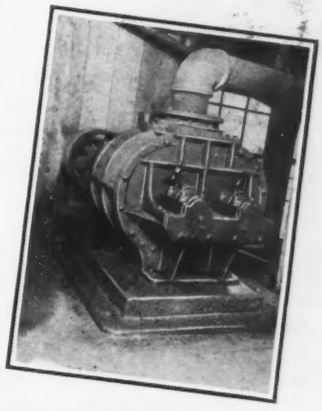
Ask for complete information about these Connersville Blowers and particularly the new "R-S" Series.



Connersville Blower supplying air for 150 ton copper matte blast furnace. Calaveras Copper Co., Copperopolis, Cal.



At D. W. Peeples Mill. Wardner, Idaho.



At Throndson Mill, Wardner, Idaho.

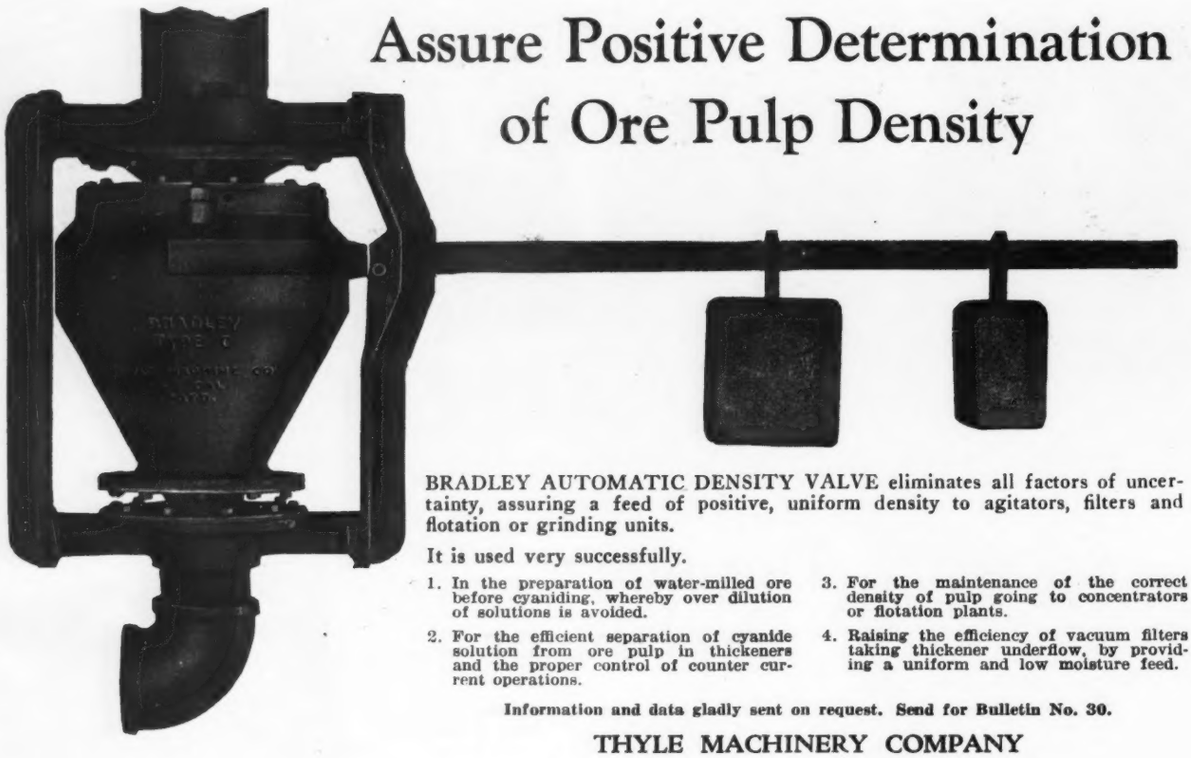
The Connersville Blower Co.
Mount & Kentucky Ave.,
Connersville, Indiana

Branch sales offices are maintained at 53 W. Jackson Blvd., Chicago, 114 Liberty Street, New York, and the Chamber of Commerce Building, Pittsburgh. You can also obtain this information through your local supply house.

CONNERSVILLE

Blowers · Gas Pumps · Meters · Cycloidal Pumps

Assure Positive Determination of Ore Pulp Density



BRADLEY AUTOMATIC DENSITY VALVE eliminates all factors of uncertainty, assuring a feed of positive, uniform density to agitators, filters and flotation or grinding units.

It is used very successfully.

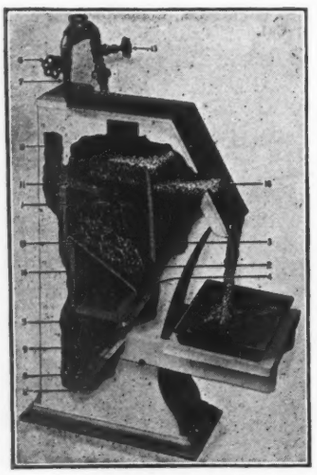
1. In the preparation of water-milled ore before cyaniding, whereby over dilution of solutions is avoided.
2. For the efficient separation of cyanide solution from ore pulp in thickeners and the proper control of counter current operations.
3. For the maintenance of the correct density of pulp going to concentrators or flotation plants.
4. Raising the efficiency of vacuum filters taking thickener underflow, by providing a uniform and low moisture feed.

Information and data gladly sent on request. Send for Bulletin No. 30.

THYLE MACHINERY COMPANY

129 Fremont St. San Francisco, Cal.

Represented East of the Mississippi River by the Dorr Company
247 Park Avenue, New York, N. Y.



Simpson Pneumatic

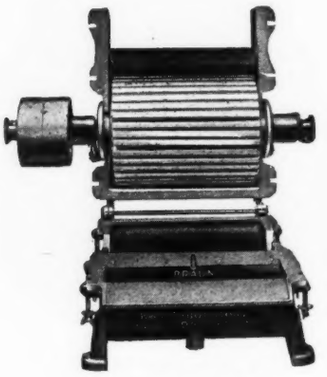
Improve Recoveries

with help of Laboratory Flotation Machines

Simpson Pneumatic Laboratory Flotation Machine, operated solely by air, carries on and closely controls the entire flotation process without a single mechanical moving part. Maintains a steady circulating load—Keeps pulp, water, froth, and concentrates under complete control—Gives thorough agitation and aeration—Shipping weight, one cell unit, 100 lbs.—Price $100 f.o.b. Los Angeles.

Another Type

Braun K & K Laboratory Flotation Machine equipped with tight and loose pulleys for belt drive, a miniature of the standard size K & K machines successfully used in regular flotation work. Shipping weight, 205 lbs. Price $125 f.o.b. Los Angeles.



Braun K & K Type

BRAUN Products Include:

Crushers, Pulverizers, Iron Ore and Coal Grinders, G-H Consistency Testers, Electrolytic Outfits, Furnaces—Muffle, Crucible and Combination, Flotation Test Machines, Rotarex Asphalt Testers, Oil Stills, Evaporators, and Samplers.

The Braun Corporation

363 New High Street ~ Los Angeles

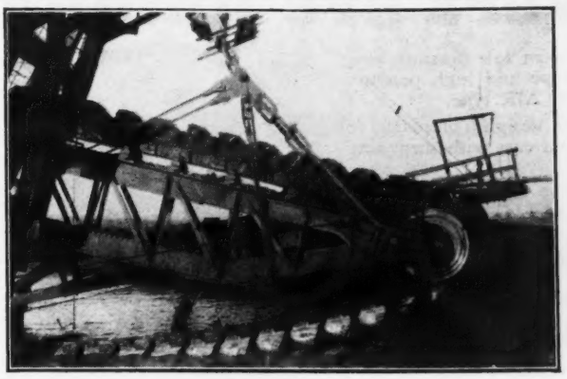
San Francisco House, Braun-Knecht-Heimann Co.

BRAUN Service Includes:

Zinc Shavings	Mercury
Cyanide	Calmix Cupels
Sodium Sulphide	Pyrex Glassware
Borax Glass	Crucibles

Heavy & Reagent Chemicals

BRAUN LABORATORY APPLIANCES—*Standard the World Over!*



"Gee, what a hungry brute"!

—said an engineer as he watched the bucket line digging into the surface gravel, making space for its under-surface operation.

"How much gravel does one of those buckets carry? How many buckets on a line? How deep can it dig? What does it do when it hits a rock? How much does it cost to handle a yard of gravel?

Questions without end. The fellow who answers must not guess, must know his business. And that is the real point of this advertisement:

Yuba Engineers have had long and varied experience in actual operation in many fields, besides their training in designing and construction of dredges.

Theory is always good—practical operating experience in addition is better. Yuba engineers have both.

* * *

YUBA MANUFACTURING CO.

351 CALIFORNIA STREET
SAN FRANCISCO, CALIF.
CABLE—YUBAMAN

Plants at Marysville and Benicia, California

Up-to-date methods in Non-Ferrous Metallurgical Analysis

covering the determination of all principal elements in non-ferrous metals, ores, intermediary products, etc.

for the chemist and the manufacturer—

Here are analytical methods as they are used today in the laboratories of leading non-ferrous metallurgical companies. The directions are so clear—so definite and concise—that they may easily be followed even by operators of limited experience.

Methods in Non-Ferrous Metallurgical Analysis

By ROBERT KEFFER
Late Research Chemist, Anaconda Copper Mining Company
in collaboration with
CHARLES D. McNEIL
Assistant Research Chemist, Anaconda Copper Mining Company
Prepared for publication by
ALLISON BUTTS
Assistant Professor Metallurgy, Lehigh University

Just Out!

All the methods given have been thoroughly tested both through routine use and by special tests to prove their accuracy. They include old methods which have met the test of constant use over long periods of time, desirable modifications of some of the older methods, and new methods developed by the author and others. Particular methods to be used for special cases or conditions are pointed out. In giving directions the authors include:

——The exact amount of reagents to be used
——method of preparing the reagents.
——type of filter paper found most suitable
——exact procedure for evaporation, ignition, titration, etc.
——factors for calculating results.

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25. Selenium and Tellurium
26. Silicon
27. Sulphur
28. Tin
29. Titanium
30. Tungsten
31. Uranium
32. Vanadium
33. Zinc
34. Acids and Alkalies
35. Analysis of Xanthates

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FREE EXAMINATION COUPON

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You may send me on 10 days' approval Keffer—Methods in Non-Ferrous Metallurgical Analysis, $4.00 postpaid. I agree to remit for the book or return it postpaid within ten days of receipt.

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(Books sent on approval to retail purchasers in the U. S. and Canada only.) J. 12-22-28

Why Coppus Blowers are unique

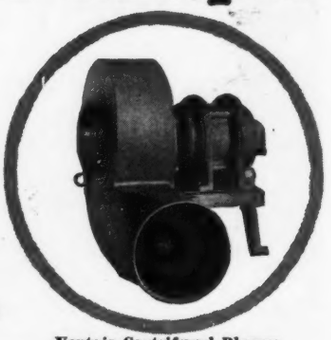
Vano Propeller Blower

1. Because we differentiate between low pressure propeller fans of the VANO type and high pressure centrifugal fans of the VENTAIR type.
2. Because we select the proper design (propeller or centrifugal) in each individual case with surprising H. P. economy.
3. Because our machines are not just "blowers," but fans especially built for highly efficient Mine Ventilation.
4. Because our fans have non-overload characteristics.

Read bulletin 123

Coppus Engineering Corporation

356 Park Ave., Worcester, Mass.

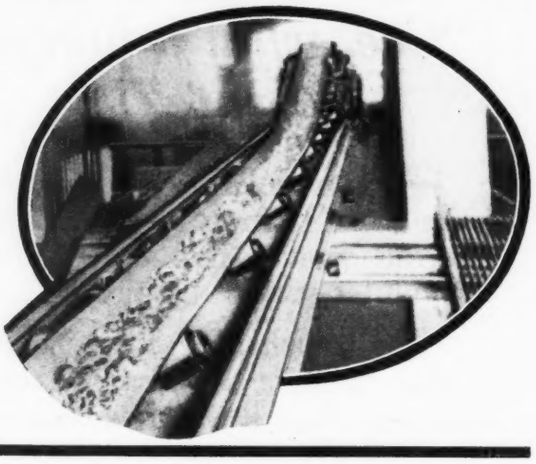


Ventair Centrifugal Blower

WEBSTER

Belt Conveyors—Trippers—
Hoppers—Bucket Elevators—
Chains—Sprockets, etc.

THE WEBSTER MANUFACTURING CO.
1856 N. Kostner Ave., Chicago, Illinois



Overstrom *Universal* Concentrating Tables

HANDLE material from 4 mesh to slimes. Motion keeps concentrates from upper side of riffles, allowing only sand to wash over. Whole deck area effective. Concentrates travel away from tailings discharge side. Stroke adjustments made in few seconds. Remarkably simple—nothing to wear out. Great capacity—little power—unsurpassed efficiency. Full details in Bulletin No. 105.

STRAUB MFG. CO.
507 CHESTNUT ST., OAKLAND, CALIF.

Our completely equipped ore testing plant available. Ores handled under field conditions. Experienced engineers will make complete tests, reports and flow sheets.

SUPERIOR MINING MACHINERY
Standard or Sectionalized

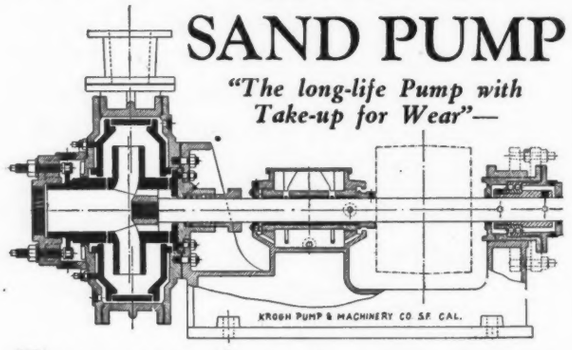
Crushers, Stamp Mills, Boilers, Rib-Cone Ball Mills, Hoists, Smelting

"Anywhere a Mule Can Go"

Furnaces, Flotation Cells, Amalgamation Plates, Dredges.

THE NEW
KROGH SAND PUMP

"The long-life Pump with Take-up for Wear"—



The greatest advance in pump construction during the past ten years. Write for new Bulletin 98.

We continue to manufacture the old type Krogh open runner sand pump so popular in the industry.

The Krogh Pump & Mach. Co.
147 Beale St., San Francisco

KROGH
TRADE MARK

"Pumps Built for Endurance"

Drill Bits
require expert tempering

Just a few degrees "off the range" during heat treatment of drill bits, very often results either in total loss of expensive drills or at best a drill of inferior quality. Which usually means shortened service life at the face, and costly interruption in production.

. . . On the other hand when forge heats are automatically regulated by

BRISTOL'S
Pyrometer Control Equipment

Not only can *more* drills be sharpened and hardened per day, but *every drill will be of the same uniform quality.*

Such control is accomplished by the Bristol's Model 479 Controller shown above, which acts together with suitable Bristol's motor operated controller valves to automatically regulate the supply of fuel gas and air to burners. Thus the correct heat is constantly held within narrow limits.

Simple in design and ruggedly constructed throughout, Bristol's Control Equipment has acquired an enviable reputation for accuracy and by trouble free performance—even after several years' service. And *maintenance* cost is practically nothing.

Sales Engineering Service without obligation. Write.

The Bristol Company
Waterbury, Conn.

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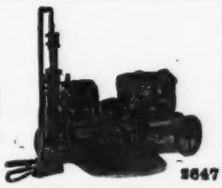

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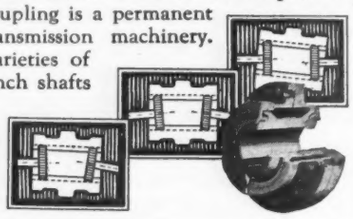

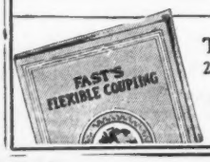

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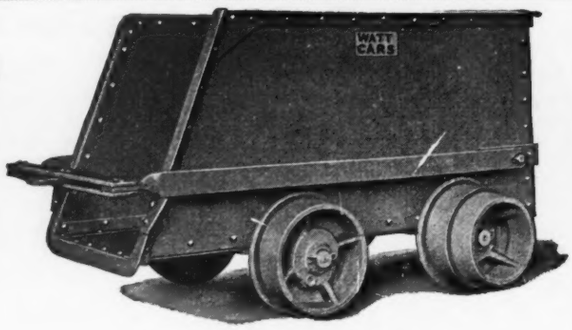

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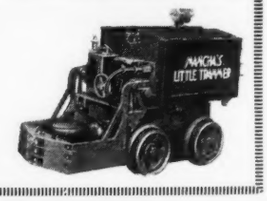

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Specialties
Tutoring
Miscellaneous For Sale, For Rent and Wanted

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SEARCHLIGHT DEPT.

Tenth Ave. at 36th St., New York

EMPLOYMENT SERVICE

$3,000.00—$30,000.00 men find our service effective in making connections. Individual. Confidential. Refund agreement. Not agency. Jacob Penn, Incorporated, 9 Park Place, New York.

IF YOU are qualified for position between $2,500 and $25,000, and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service, established nineteen years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not a registration bureau. Retaining fee protected by refund provision as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc., 264 Main Street, Buffalo, New York.

$2,000 to $20,000 salaried positions — any location. For engineers and executives who seek a better position we offer a confidential, individualized service whereby preliminary negotiations are conducted for such positions. The procedure conforms strictly to your preferences and qualifications. A. L. Bryan Personnel Company, 836-846 East Jefferson Street, Louisville, Ky.

POSITIONS WANTED

BORING engineer, core drill expert; can speak Spanish, Portuguese and Swedish; will go anywhere; available immediately. 1611 Rose Street, Berkeley, California.

CHEMIST-Assayer, single, twenty-five years of age, with four years' experience in Western mines and smelters, desires new connection with good reliable company, preferably Southwest or Northern Mexico. PW-923, Engineering and Mining Journal, 7 So. Dearborn St., Chicago, Ill.

ENGINEER, technical graduate, 28, single, speak Spanish, desires position with company needing man who has practical experience in mining, milling, engineering and assaying. PW-913, Engineering and Mining Journal, 7 South Dearborn St., Chicago, Ill.

METALLURGIST-chemist, 8½ years' college and technical training. 4½ years' practical experience. Four years' sales experience. PW-921. Engineering and Mining Journal, 7 So. Dearborn St., Chicago, Ill.

MINING engineer, technical graduate with broad operating and business training, is open for position. Address PW-887, Engineering and Mining Journal, 7 South Dearborn St., Chicago, Ill.

MINING metallurgist, mill superintendent or assistant. Technical, twenty years' practical experience in milling processes, flow sheet design, cost estimation and mill operation. Extensive experience directing flotation mill operation and laboratory research on lead-zinc, copper, silver ores, also flotation on oxidized and semi-oxidized ores, chloridizing roast leaching and cyanidation. Twelve years past, mill superintendent and directing metallurgist for large lead-zinc, copper, silver flotation concentrator. Credentials gladly furnished. R. V. Thompson, 917 Fourth Street, Santa Monica, Calif.

POSITIONS WANTED

MINING engineer, geologist, 40, married, technical graduate, 17 years' experience milling, mining, engineering, mine examinations and geological surveys in Southwestern United States, Latin America and Canada. Desires connection with reliable company as manager, assistant manager, or examining engineer. Speak Spanish. Highest references. Available immediately. PW-922, Engineering and Mining Journal, 7 So. Dearborn St., Chicago, Ill.

SALVAGE expert and metallurgist; executive and technical graduate, who can handle men, methods and materials to produce metal refining profits. Fifteen years operating in primary copper, lead and secondary metals, reclaiming and refining. Technician capable of originating and directing your scrap reclaiming operations to yield maximum returns. PW-909, Engineering and Mining Journal, Tenth Ave. at 36th St., New York.

SUPERINTENDENT lead smelter, American, graduate metallurgist, sixteen years' experience copper and lead smelting, United States, Mexico, excellent references, available in thirty days. PW-920, Engineering & Mining Journal, Tenth Ave. at 36th St., New York.

ZINC metallurgist. Many years' experience as a chief chemist and a research chemist, and in plant in charge of roasting and zinc oxide operations. College graduate. Now employed. References. PW-917, Engineering and Mining journal, 7 South Dearborn Street, Chicago, Ill.

BUSINESS OPPORTUNITIES

INQUIRIES solicited from corporations interested in raising capital through marketing of corporate securities. Brookworth, Inc., 110 E. 42nd St., New York.

WANTED

Used Carbon (Black Diamonds), large or small; will pay best prices. Payment made return mail for merchandise purchased. Maurice S. Dessau, 6 Maiden Lane, New York City.

Copper Development

Ideal Copper Property, 340 acres with 400 foot shaft, two drifts, located in Globe District adjoining large going company. For information write

RUFUS WALKER, Moline, Illinois

WANTED

New Equipment

New Process Company, Ltd., invite tenders to be addressed to their Head Offices, Scotts Road, Southall, Middlesex, England, for the best modern mining equipment for their proposed ore mine (Colonial); stone quarry day work. Plant to comprise surface digging, lifting by mechanical shovels, transporting, conveying, crushing, grinding, screening, leaching, filtering. Material treated is granite-like rock. Output commencing 100 to 1,000 tons per day.

USED EQUIPMENT

Re-Conditioned
Ready-to-Ship

HOISTS

1—200 hp. Box Iron Works Electric Hoist, single drum, 60 in. dia. x 42 in. face, driven by 200 hp. Westinghouse Motor, 3 phase, 60 cycle, 440 volt.

1—75 hp. Denver Engineering Works Electric Hoist, single drum, 36 in. dia. x 27 in. face, driven by 75 hp., 3 phase, 60 cycle, 440 volt Motor, reversible drum control and resistance.

1—225 hp. Double Drum Electric Hoist, drum 72x30 in., friction clutches, and band brake. Clutch air operated. Herringbone gears, driven by 225 hp., 3 phase, 60 cycle, 550 volt Motor. Reversible drum control and resistance.

1—225 hp. Double Drum Hoist, drum 72x30 in., friction clutches, air operated, driven by 225 hp., 3 phase, 60 cycle, 440 volt, 350 r.p.m. Motor, reversible drum control and resistance.

1—75 hp. Denver Engineering Works Electric Hoist, double drum, 32 in. dia. x 24 in. face, friction clutches, band brake and bar indicator. Complete with 75 hp. hoist motor, 3 phase, 60 cycle, 440 volt. Reversible drum control and resistance.

4—Model 250 Waugh Hoists, single drum, 5 hp.

1—No. 5 Super-Leadville Hoist, single drum, 5½ hp.

1—No. 3 Leadville Hoist, single drum, 3 hp.

5—Model 300 Waugh Hoists, double drum, 10 hp.

1—No. 10 HR Ingersoll-Rand Little Tugger Hoist.

1—1-H Ingersoll-Rand Hoist, single drum, 3½ hp.

Note: We have a good stock of reconditioned geared hoists, and friction hoists, single and double drum, steam driven. We also have several good contractors hoists. All this equipment has been thoroughly reconditioned and is ready to ship. Write for our prices and complete specifications.

"Everything for Mine, Mill and Smelter."

The Morse Bros. Mach. & Supply Co.
P. O. Box 1708, Denver, Colo.

PUMPS (STEAM)

1—Worthington duplex, 3½ x 2¾ x 4.
1—Burnham single acting, 5 x 8 x 10.
1—Fairbanks-Morse duplex, 7 x 5 x 7.
1—Snow double acting steam, 7 x 3½ x 8.
1—Gardner duplex steam, 10 x 6 x 10.

PUMPS (MISCELLANEOUS)

1—Gould power head, 20-in. stroke, with 6-in. cylinders.
1—Jackhead, 3-in. x 4-ft., with head gear and pump rod connections.
1—Frenier sand pump, 56-in. x 10-in.
1—Gould vacuum pump, 14 x 14, belt drive, 1400 gallons displacement.

PULLEY (MAGNETIC)

1—Magnetic Manufacturers pulley, 110 volt, 5 amps., type VP, size 14 x 18, with belt driven generator.

RAIL

WE CARRY A LARGE STOCK OF NEW AND SECOND HAND RAIL FROM 12-LB. to 30-LB.

RECEIVERS (AIR)

4—14-in. x 30-in.
2—16-in. x 48-in.
1—36-in. x 8-ft.
1—42-in. x 84-in.
2—48-in. x 96-in.
1—48-in. x 15-ft.6-in.
1—48-in. x 19-ft.

ROLLS

1—Set Allis-Chalmers, style "B", 30 x 10.
2—Sets Allis-Chalmers, 40 x 15.

WATCH for NEXT WEEK'S ADVERTISING LIST OF OUR STOCK

Write for complete stock list No. 17 covering all kinds of Mining and Milling Equipment. Get our low prices!

J. E. KNAPP CO.
525 Market Street, San Francisco, Calif.
Telephones: Garfield 4783 & 4784

Guaranteed Rebuilt EQUIPMENT

Write for Prices

MILL EQUIPMENT

WEIGHTOMETERS

2—Merrick Patent Weightometers for weighing crushed ore carried on 16-in. belt conveyor, speed 100-ft. per minute, hourly capacity, 15 to 30 tons, complete and in guaranteed condition.

FLOTATION BLOWERS

2—Connersville Boston Type High Pressure, capacity 6890 cu.ft. per minute each, pressure 5½ lbs.
1—Connersville Boston Type High Pressure, capacity 2000 cu.ft. per minute, pressure 6 lbs.
1—No. 8 Sturtevant High Pressure Blower, capacity 2890 cu.ft. at 5 lbs. pressure.
1—No. 9 Sturtevant Pressure Blower, capacity 3500 cu.ft. at 2 lbs. pressure.

CLASSIFIERS AND THICKENERS

1—Dorr Model "C" Simplex Classifier, size 2-ft.6-in.x14-ft.x8-in.
2—Dorr Model "C" Duplex Classifiers, size 4-ft.6-in.x14-ft.x8-in.
1—Dorr Model "D" Duplex Classifier, size 6-ft.x22-ft.
1—Dorr Thickener Mechanism, size 85-ft.x10-ft., complete with steel superstructure.
2—Dorr Thickener Mechanisms, size 30-ft.x7-ft. and 9-ft., complete with redwood tanks.

"Service and Quality at a Saving in Cost" (1)

Eastern Iron & Metal Company
634 So. 4th West St., Salt Lake City, Utah

FOR SALE

320B Bucyrus Stripping Shovel
Shop No. 3883

Excellent Condition—Now located along R.R. tracks ready to ship. Address

DAWSON DAYLIGHT COAL CO.
Dawson Springs, Ky.

For Sale $350 F.O.B. Cars

Southwark Rateau Turbine, No. 9

Steam pressure 150 lbs., steam intake 4 in., direct connected to Smoot Centrifugal Pump, 2,200 r.p.m., capacity 5,200 g.p.m., 14 in. suction, 14 in. discharge, 120 ft. head.

R. M. GRIFFITHS, Pottsville, Pa.

FOR SALE

1—6-ft.x16-in. Hardinge Mill.
2—New unused, 14-ft. Gayco-Emerich Air Separators.
1—10-ft. Gayco Separator.
1—5-ft. 6-in.x20-ft. Smidth Tube Mill.
2—8-ft.x22-in., 8-ft.x30-in. Hardinge Mills.

All sizes of Hardinge, Ball and Tube Mills; Rotary Kilns; Jaw, Gyratory and Roll Crushers; Oliver, Sweetland and other filtering equipment. SEND US YOUR INQUIRIES.

Consolidated Products Company, Inc.
13-19 Park Row, New York City. Barclay 0693
Shops and Yards at Newark, N. J. covers six acres.

TUBE MILLS

1—5-ft. x 16-ft. Colo. Ir. Wks., El Oro Lined.
1—4-ft. x 10-ft. Denv. Eng. Wks., Silex lined.

ROD MILLS

1—3-ft. x 9-ft. Ruth Rod Mill.
1—3-ft. x 7-ft. Ruth Rod Mill.
1—4-ft. x 9-ft. Ruth Rod Mill.

BALL MILLS

1—4-ft.x3-ft. Denv. Engr. Wks., Steel Lining.
2—4½-ft. x 13-in. Hardinge Conical.
4—5-ft. x 5-ft. Colo. Iron Works.
2—6-ft. x 22-in. Hardinge Conical.

CRUSHING ROLLS

1—Set 5-in. x 16-in. Finishing Rolls.
1—Set 12-in. x 20-in. McFarlane & Co.
2—Sets 12-in. x 30-in. Pow. & Mining Mchy. Co.
2—Sets 14-in. x 27-in. Traylor Eng. Works.
1—Set 14-in. x 27-in. Hendrie & Bolthoff.
1—Set 14-in. x 30-in. Power & Mining Machinery Co.
1—Set 16-in.x36-in. Denver Engr. Works.
1—Set 16-in. x 40-in. Colorado Iron Works.

PULVERIZERS

1—Special D Williams Hammer.
1—No. 30 Steadman Disintegrator.
1—Size 12½, 24-in. Bauer Bros. Disc.
1—No. 16 Foos Attrition Mill.

The above is only a small part of our large stock. Send for complete list and prices.

The Denver Metal & Machinery Co.
130 Larimer St., Denver, Colo.,
Est. 1898. (2)

Used Machinery For Sale

1—8-ft., 1—6-ft., 1—4½-ft., 1—3-ft Hardinge Mills.
No. 10, No. 9, No. 8, No. 6 and No. 5 Gyratory Crushers.
3x15-ft., 4½x36-ft., 6x60-ft. and 6x100-ft. Rotary Kilns.
40-in.x42-in., 30-in.x42-in., 24-in.x36-in., 18 in.x36-in., 12-in.x24-in., 11-in.x22-in., 8 in.x10-in., 6-in.x3-in. Jaw Crushers.
54x24, 30x16, 24x12, 16x10 Crushing Rolls
3x30-ft., 4x30-ft., 5x40-ft., 6x60-ft., 8x80 ft. Rotary Dryers.
No. 0, No. 1, No. 1½ and No. 2 Sturtevant Rotary Fine Crushers.
12x12-ft., 6x6-ft., 6x3-ft. and 14x14-in. Oliver Rotary Filters.
Jigs, Concentrating Tables, Screens, Air Separators, Classifiers, Ball and Tube Mills, Swing Hammer Mills, Thickeners.

Heineken Engineering Corporation
Cortlandt 5130-1 117 Liberty St. New York

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—to help you get what you want.

—to help you sell what you no longer need.

Take Advantage Of It

For Every Business Want

"Think SEARCHLIGHT First"

G-36

FOR SALE

19 Miles of 56-lb. Rails, Angle Bars, stored at Belle-Fourche, S. D.
3—Box Cars.
2—60-ton Locomotives, standard.
1—Caboose.
1—80,000 Cap. Gondola.
1—6-Passenger Motor Car, Touring.

Write or Wire.

Sonken Galamba Corp.
Kansas City, Kansas

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For Every Business Want
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FOR SALE

AT LOW PRICES

1—"U" Shape All Steel Storage Bin, capacity about 200 tons of coal.
325—9x12x12-inch "V" Shape Elevator Buckets.
2—33-ton standard gauge Saddle Tank Locomotives.
2—8x6-ft. Kennedy Ball Mills.
1—18x24-in. Spike Crushing Rolls.

Motors—3 ph., 60 cy., 440 v.

1—200 hp., 450 r.p.m.
2—150 hp., 440 r.p.m.
1—40 hp., 1,700 r.p.m.
1—13 kw., 900 r.p.m., 125 volt, D.C. Belt Driven Generator.
1—9x100-ft. Rotary Kiln.
1—8x125-ft. Rotary Kiln, four tire.
3—4½x44-ft. Rotary Kilns.
1—No. 9-K Allis-Chalmers Gyratory Crusher.
1—No. 7½ Kennedy Gyratory Crusher.

THE EQUIPMENT SALES CO.
R. W. STORRS, JR., *Manager*
Richmond, Virginia

COMPRESSORS

Portable

2—210 ft. Ingersoll Imp. Ty. 14.
3—220 ft. Ingersoll Imp. Ty. 20
1—250 ft. Ingersoll Imp. Ty. 20

U. S. Machinery & Steel Co.
750-752 Folsom St., San Francisco

A few items from our large stock of Mine and Mill Equipment

RADIAL DRILL
1—Fosdick, 36-in. arm.

DRYERS AND ROASTERS
1—24-in. and 36-in. Dia. 18 ft. long, steel shell, New.
1—24-in. and 30-in. Dia. 30 ft. long, steel shell. New.
1—43-in. and 60-in. Dia., 22-ft. long, CI shell. New.
2—Wedge Mechanical, 22-ft.6-in. Dia. 7-ft. Hearth, equipped with air cooled arms, all countershaft eqpt., etc.
2—Cottrell Treaters, with Westinghouse Generating and transforming eqpt. used with above Wedge Roasters.

ELEVATORS—BELT AND BUCKET
2—50-ft. centers, 16-in. Belt, 73-13-in. Buckets.
1—35-ft. centers, 12-in. Belt, 12-in. Buckets.
1—45-ft. centers, 10-in. Belt, 95-8-in. Buckets.
1—36-ft. centers, 10-in. Belt, 75-8-in. Buckets.
1—40-ft. centers, 8-in. Belt, 56-7-in. Buckets.
1—30-ft. centers, 8-in. Belt, 46-8-in. Buckets.
1—28-ft. centers, 6-in. Belt, 29-5-in. Buckets.
1—30-ft. centers, Chain, 7-in. Buckets.
1—25-ft. centers, Chain, 6-in. Buckets.
All above complete with head and tail driving mechanism, etc.

ELEVATORS—PLATFORM
1—3-Ton Otis, Elec. Frt. type, 8-ft.x8-ft. platform, 74-ft. travel, 500 V.-DC Motors.

ENGINES—GASOLINE
1—60 HP. Fairbanks-Morse, Horizontal.
1—55 HP. Doak, Horizontal.
1—10 HP. Alamo, Horizontal.
1—9 HP. Union, Horizontal.

ENGINES—OIL
1—200 HP. Fairbanks-Morse, type Y.
1—12 HP. Chicago Pneumatic, type AO.

Send to our nearest office for complete stock list and prices. Let us know what you have for sale as we are always in the market for good used equipment.

MACHINERY SALES AGENCY
760 Folsom St., San Francisco
215 West 7th St., Los Angeles
209 Luhrs Bldg., Phoenix, Ariz.
260 South 6th West St.
Salt Lake City, Utah

The advertisements in the
SEARCHLIGHT SECTION
of this paper

constitute the most comprehensive group of "live" opportunities to be found in any publication serving this industry.

Each announcement represents a current Want of a concern or individual in the industry with some element of profit in each for whoever can fulfill the need. Some have money saving possibilities, others are opportunities for more business; many are employment opportunities while still others offer chances to buy going businesses, plants, property, etc.

"Searchlight" advertisements are constantly changing. New opportunities find their way into this great Want medium each issue. Regular consultation of the "Searchlight" pages should be as important to the careful reader as reading editorial articles of his particular liking. One is news of the industry, the other, the NEWS OF OPPORTUNITIES being offered in the industry. No one can afford to overlook opportunities.

For Every Business Want
"Think SEARCHLIGHT First"

0140

WHAT AND WHERE TO BUY

A Classified Index of Advertisers in This Issue

This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Engineering and Mining Journal* assumes no responsibility for errors or omissions

[For Alphabetical Index See Last Page]

Acid, Sulphuric
Matthiessen & Hegeler Zinc Co.

Aerial Tramways
American Steel & Wire Co.

Aftercoolers, Air
Ingersoll-Rand Co.

Agitators
Allis-Chalmers Mfg. Co.

Amalgamators
Allis-Chalmers Mfg. Co.

Arsenic
Amer. Smelting & Ref. Co.
United Metals Selling Co.
U. S. Smelting, Refining & Mining Co.

Ash Handling Systems
Robins Conveying Belt Co.

Assayers
Baker & Co., Inc.

Bag Houses
Wiederholdt Cons. Co

Balls, Grinding
Hardinge Co.

Bars, Iron and Steel
Ryerson & Son, Inc., J. T.

Bearings, Ball & Roller
Dodge Mfg. Corp.

Bearings, Bronze Babbitt
Dodge Mfg. Corp.

Belt Fasteners
Bristol Co., The

Belting Conveyor
Robins Conveying Belt Co.

Belting, Elevator
Robins Conveying Belt Co.

Black Diamonds, Carbons (See Diamonds, Black, Core Drill)

Blowers
Conners-ill Blower Co.
Coppus Engineering Corp.
General Electric Co.
Ingersoll-Rand Co.
Roots Co., The P. H.& F.M.

Blowing Engines
Nordberg Mfg. Co.

Blowpipes Welding & Cutting
Oxweld Acetylene Co.

Boilers
Abendroth & Root Mfg. Co.
Straub Mfg. Co.

Brick, Fire
General Refractories Co.

Buckets, Elevator
Link-Belt Co.
Robins Conveying Belt Co.
Webster Mfg. Co.

Car Hauls
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.
Wellman-Seaver-Morgan Co.

Carbon, Core Drill
Diamond Drill Carbon Co.

Cars, Gable Bottom
Watt Car & Wheel Co.

Cars, Hopper
Watt Car & Wheel Co.

Cars, Ore
Atlas Car & Mfg. Co.
Watt Car & Wheel Co.

Cars, Quarry
Atlas Car & Mfg. Co.
Watt Car & Wheel Co.

Castings, Heat and Acid Resistant
Pacific Foundry Co.
Westinghouse-Nuttall

Castings' Iron and Steel
Allen & Co. Ltd., Edgar
Pacific Foundry Co.
Vulcan Iron Works

Chains, Transmission
Link-Belt Co.

Chemical Apparatus
Braun Corporation
Braun-Knecht-Heimann Co.
Oliver-United Filters Inc.

Chimneys
Wiederholdt Cons. Co.

Chimneys, Acid Proof, Radial Brick and Reinforced Concrete
Costodis Chimney Const. Co.

Circuit Breakers, Electric
Ohio Brass Co.

Clamps, Trolley Wire
Ohio Brass Co.

Clarifiers
Hardinge Co.

Classifiers
Allis-Chalmers Mfg. Co.
Deister Machine Co.
Dorr Co.

Clutches, Friction
Dodge Mfg. Corp.
Link-Belt Co.

Coal and Ore Handling Machinery
Link-Belt Co.
Stephens-Adamson Mfg. Co.

Coal Cutters
Flottmann Machine Works
Ingersoll-Rand Co.
Sullivan Machinery Co.

Cocks
Lunkenheimer Co., The

Compressors, Air
Allis-Chalmers Mfg. Co.
Flottmann Machine Works
Ingersoll-Rand Co.

Compressors, Air, Portable.
Ingersoll-Rand Co.
Sullivan Machinery Co.

Compressors, Gasoline
Sullivan Machinery Co.

Concentrators, Table
Allis-Chalmers Mfg. Co.
Cottrell Engineering Co.
Deister Concentrator Co.
Deister Machine Co.
Morgan Co., F. S.
Straub Mfg. Co.

Condensers
Ingersoll-Rand Co.
Southwestern Eng'rg Co.

Consulting Engineers
Swedish American Prospecting Corp.
(Rogers Mayer & Ball)

Contractors, Diamond Drilling
Sprague & Henwood Inc.
Sullivan Machinery Co.

Converters, Horizontal and Vertical
Allis-Chalmers Mfg. Co.

Conveyors and Elevators
Allis-Chalmers Mfg. Co.
Dodge Manufacturing Corp.
Flottmann Machine Works
Link-Belt Co.
Robins Conveying Belt Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Conveyors, Belt
Dodge Manufacturing Corp.
Link-Belt Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Conveyors Chain Flight
Webster Mfg. Co.

Coolers
Sullivan Machinery Co.

Copper
American Metal Co.
American Smlg. & Refg. Co.
Nichols Copper Co.
U. S. Smelting, Refining & Mining Co.

Copper Sulphate
Irvington Smelting & Ref. Co.
Nichols Copper Co.

Core Drill Diamonds
Diamond Drill Carbon Co.

Couplings
Bartlett-Hayward Co.

Couplings, Air Hose
Cleveland Rock Drill Co.

Couplings, Shaft
Dodge Mfg. Cop.

Cranes, Locomotive
Link-Belt Co.

Crushers
Allen & Co. Ltd., Edgar
Allis-Chalmers Mfg. Co.
Braun Corporation, The
Braun-Knecht-Heimann-Co.
Colorado Iron Works
Smith Engineering Works
Webster Mfg. Co.

Cups, Grease (See "Grease Cups")

Dealers, Machinery Rails, Pipe & Misc. Equipment
Consolidated Prod. Co.
Denver Metal & Machinery Co.
Eastern Iron & Metal Co.
Equipment Sales Co.
Heinecken Engrg. Corp.
Knapp Co., J. E.
Machinery Sales Agcy.
Morse Bros. Machy. & Supply Co.
Sonken & Galamba
United Commercial Co., Inc.

Dewaterers
Thyle Machinery Co.

Diamonds, Black, Core Drill
Diamond Drill Carbon Co.
Straub Mfg. Co.

Dredges
Yuba Manufacturing Co.

Dredges, Placer
New York Engineering Co.
Sullivan Machinery Co.

Drills, Air and Steam
Cleveland Rock Drill Co.
Ingersoll-Rand Co.

Drills, Core
Dobbins Core Drill Co., Inc.
Ingersoll-Rand Co.
Sprague & Henwood Inc.
Sullivan Machinery Co.

Drills, Diamond
Sullivan Machinery Co.

Drills, Electric
Ingersoll-Rand Co.

Drills, Hammer
Cleveland Rock Drill Co.
Flottmann Machine Works
Gardner Denver Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.

Drills, Piston
Ingersoll-Rand Co.
Sullivan Machinery Co.

Drills, Prospecting
Ingersoll-Rand Co.
New York Engineering Co.

Dust Collecting Systems and Engineers
Dust Recovering & Conveying Co.

Electrical Supplies
Ohio Brass Co.
Post Glover Electric Co.

Elevators, Bucket
Robins Conveying Belt Co.

Engineers & Contractors

Engineers, Metallurgical
Swedish American Prospecting Corp.
(Rogers Mayer & Ball)

Engineering and Technical Books
McGraw-Hill Book Co.

Engines, Diesel
Allis-Chalmers Mfg. Co.

Engines, Gas and Gasoline
Ingersoll-Rand Co.
Thyle Machinery Co.
Wellman-Seaver-Morgan Co.

Engines, Oil
Ingersoll-Rand Co.

Engines, Steam
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.

Exhausters
Coppus Engineering Corp.
Ottumwa Iron Works
Vulcan Iron Works

Feeders, Ore
Hardinge Co.
Link-Belt Co.
Southwestern Engrg. Corp.
Stephens-Adamson Mfg. Co.

Filters
Denver Equipment Co.
Laughlin Filter Co.
Oliver-United Filters Inc.
Shriver & Co., T.
Filter Fabrics Co.

Filters, Cloth Metallic
Oliver-United Filters Inc.

Filters, Concentrate
Laughlin Filter Co.
Oliver-United Filters Inc.

Filter, Cyanide
Oliver-United Filters Inc.

Flotation Cell Bottoms, Cloth
Filter Fabrics Co.

Flotation Equipment
Galigher Co.

Flotation Machines
Denver Equipment Co.
Southwestern Engrg. Corp.

Flotation Oils
General Naval Stores Co.

Flotation Reagents
Great Western Electro Chem. Co.

Flues
Wiederholdt Const. Co.

Forges, Rock Drill Steel
Ingersoll-Rand Co.
Sullivan Machy. Co.

Furnaces, Assay
Braun Corporation, The
Braun-Knecht-Heimann-Co.

Furnaces, Drying
Nichols Copper Co.

Furnaces, Laboratory
Nichols Copper Co.
Pacific Foundry Co.

Furnaces, Mechanical Roasting
Allis-Chalmers Mfg. Co.
Bethlehem Foundry & Machine Co.
Dwight & Lloyd Sintering Co.
Nichols Copper Co.
Pacific Foundry Co.

Furnaces, Rotary
Gould & Co., H. W.

Furnaces, Smelting
Allis-Chalmers Mfg. Co.
Braun Corporation
Braun-Knecht-Heimann-Co.
Combustion Engineering Corp.

Gages
Bristol Co., The

Gas Producers
Wellman-Seaver-Morgan Co.

Gauge Glasses
Jenkins Bros.

Gears
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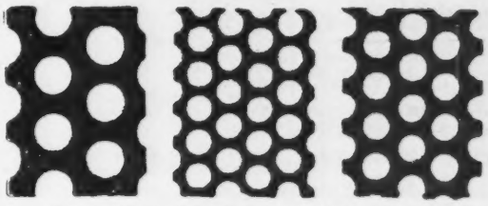

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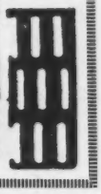

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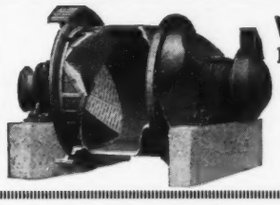

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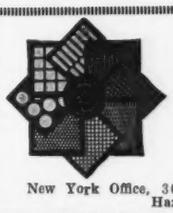

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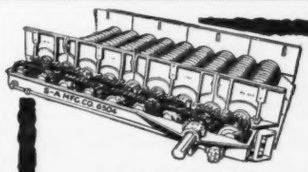

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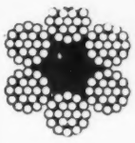

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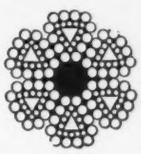

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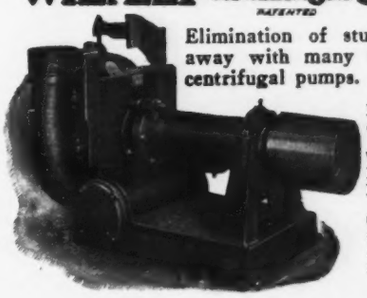

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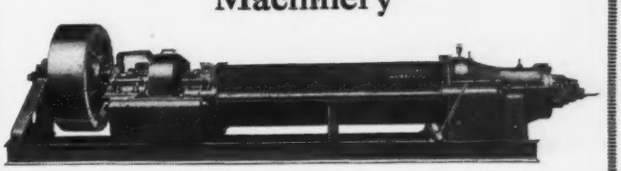

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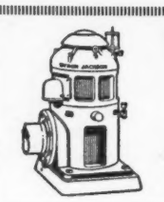

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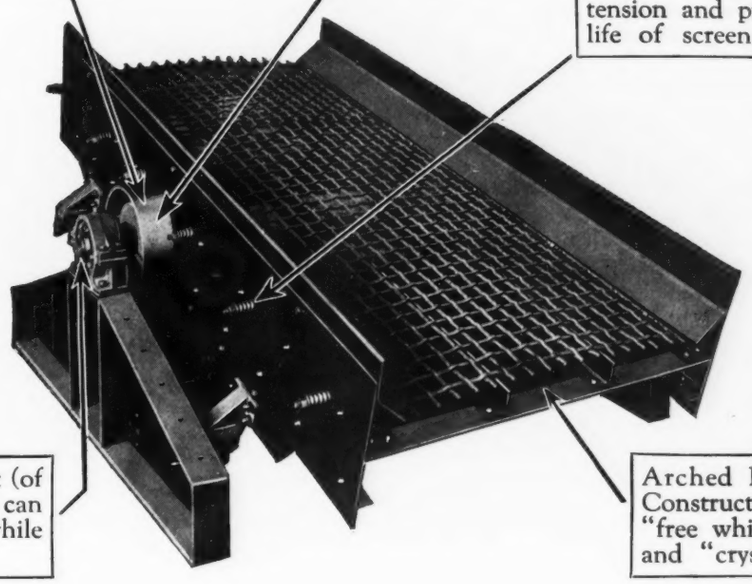
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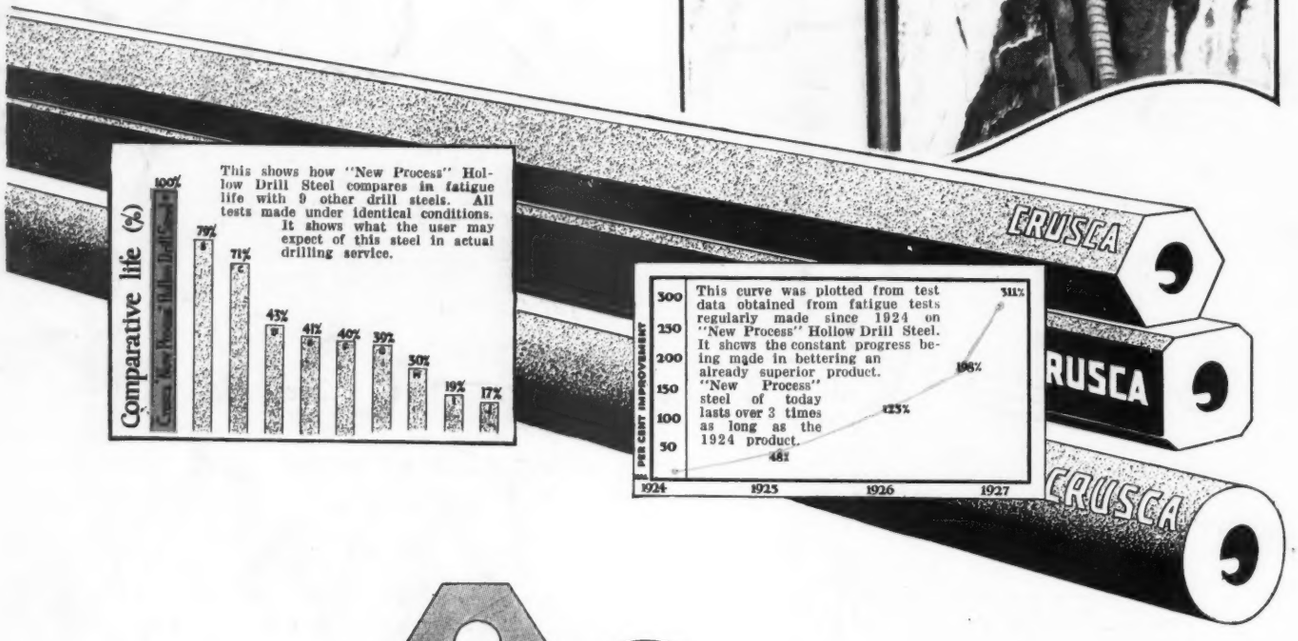

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